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CHAPTER VII

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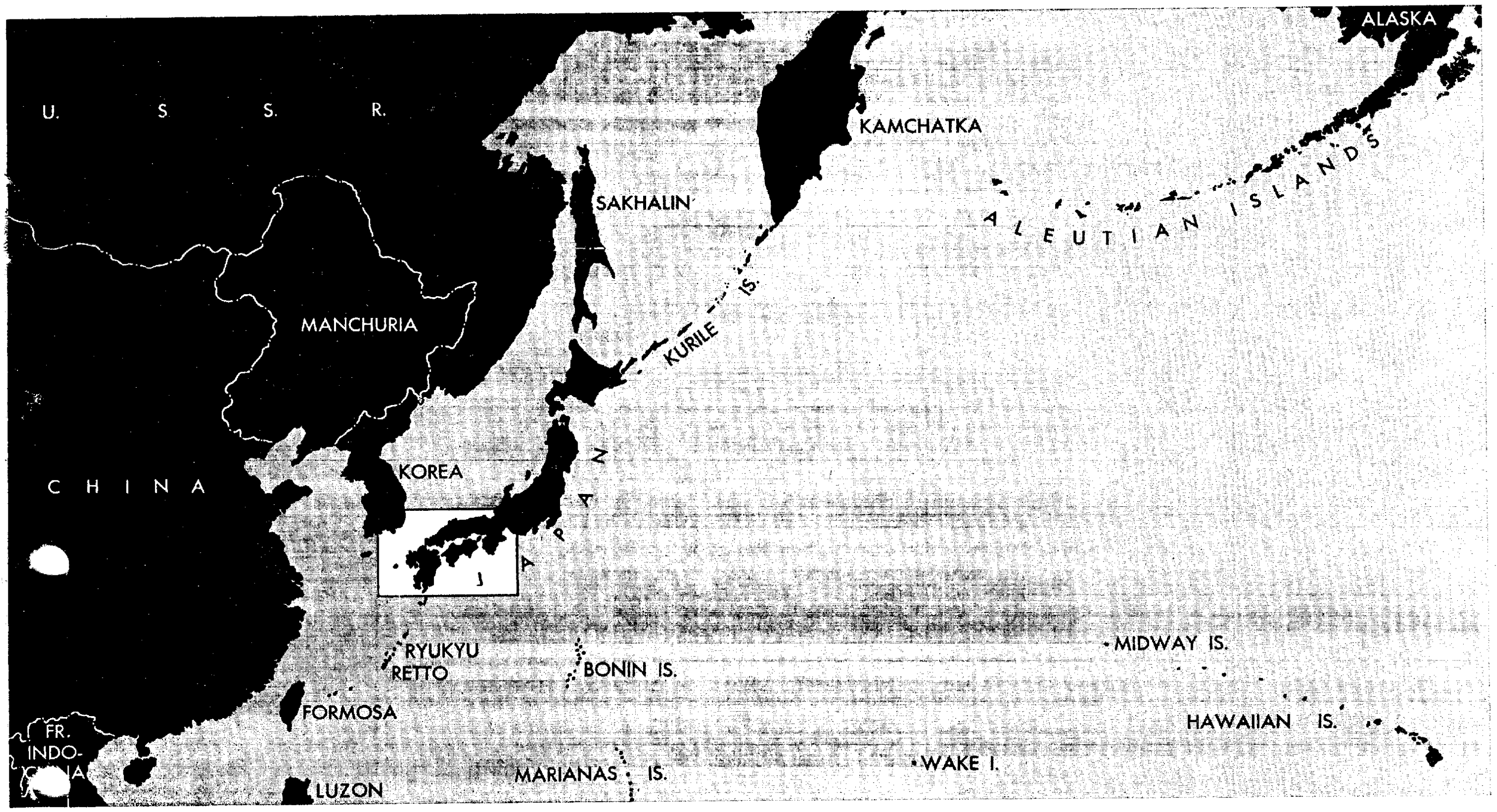

JOINT ARMY-NAVY INTELLIGENCE STUDY

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OF

SOUTHWEST JAPAN:

Kyūshū, Shikoku, and Southwestern Honshū

TRANSPORTATION AND COMMUNICATIONS

AUGUST 1944

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TRANSPORTATION AND COMMUNICATIONS

70. *General*

The most important transportation and communications corridor, as well as 3 of the 4 most important transportation centers in Japan, are included within the area defined in this study as Southwest Japan. The 3 great centers, Nagoya, Ōsaka-Kōbe-Kyōto (Kinki), and Moji-Shimonoseki, are located on the great east – west corridor route from Nagoya and Tōkyō on the east to Shimonoseki on the west. The route is most developed along the Inland Sea and its immediate littoral. Stemming out, particularly from the focal areas of this corridor, are great numbers of transportation and communications branches. This system compares favorably with the more intensively developed regional systems of western nations (FIGURES VII - 57 to VII - 59).*

A. Transportation.

As in the rest of Japan, coastal and interisland water transport assumes first place in the overall transportation picture of Southwest Japan, particularly in the Inland Sea area, where thousands of boats of all types carry literally immeasurable amounts of freight. Numerous boats criss-cross from Shikoku to Honshū, while even greater numbers skirt the Honshū shoreline, calling at the many ports which dot the seaside all the way from Ōsaka to Shimonoseki. Other important lines pass through straits on either end of Shikoku, circle Kyūshū, and connect the Moji-Shimonoseki area with Korea.

The significance of railroads in the transportation system of Southwest Japan has been accelerated by the war's increasing demands on a decreasing merchant marine. The main railroads of Japan are government-owned and operated; the remaining privately-owned branch, feeder, and suburban lines are under strict governmental supervision. Total railroad mileage in the study area is about 7,500 miles, most of which is single-track Japanese standard 3′6″ gauge. The chief route is the double-track line from Shimonoseki to Nagoya. Important local networks are associated with the Kyūshū coal area, the Kinki-chihō (area), and the Nagoya area (FIGURE VII - 58).

Steep grades, numerous curves, deep cuts, and many highly vulnerable bridges and tunnels are features of practically all lines (FIGURE VII - 1). These factors, as well as narrowness of gauge, necessitate the use of short trains and light equipment and thus are limiting factors in determining the capacity of the railroad system.

It has been only within the past 25 years that the Japanese have made any large-scale efforts to develop a modern highway system. Ease of water transport, national pride in the railroad, antagonism of railroad interests, and physical obstacles to road building in typical Japanese terrain have contributed to this lack of progress. Construction of a few national highways which follow the principal land transportation routes and form a very open net is the result (FIGURE VII - 59). The prefectural and municipal roads which were to connect these national highways are largely in the planning stage. By far the greatest number of roads fall into the categories of town or village roads, and might be considered tracks or paths rather than roads, as they are usually suitable only for such vehicles as bicycles and carts.

B. Communications.

Japan's communications services are adequate in some respects but unsatisfactory in others. Radio broadcasts reach most points in Japan and Japanese-occupied areas. Only a small part of the population, however, can obtain telephones. Land lines and submarine cables are well planned and equipped for rapid through service, but lack of maintenance and shortage of trained personnel have caused serious bottlenecks. For about 10 years, facilities have failed to expand at a rate commensurate with the need.

Southwest Japan is dotted with broadcasting stations and radiotelegraph stations (FIGURE VII - 57). In addition, contact is maintained with ships and planes by means of radiotelephone. Overseas messages, both telegraph and telephone, are handled by the Middle Japan Radio Central, with main offices in Ōsaka and Nagoya and 2 transmitting and 2 receiving stations.

Telegraph lines connect the leading cities with each other and with the mainland, but the system has received insufficient attention in recent years. Most new routes parallel those already in use or run along railroad lines. Inadequate maintenance has resulted in frequent service interruptions.

Japanese take pride in owning telephones and use them incessantly. Proposals for wide expansion of service have not materialized, however, and the present number of subscribers is probably about 1,100,000. Through circuits are available on routes where the demand is heavy; repeater stations along all long-distance lines are highly vulnerable points. Nearly all telephone exchanges and telegraph offices are located in post offices.

An extensive network of submarine cables connects Southwest Japan with the Asiatic mainland, while other lines run to various small and large islands near Japan proper (FIGURES VII - 56 and VII - 57). Areas along the Inland Sea are particularly dependent on cable communication. Nagasaki, Yobuko, and the coast just north of Shimonoseki have the greatest concentrations of long-distance submarine cable landings.

71. *Railroads*

A. Pattern and significance.
(FIGURE VII - 58)

The railroad pattern of Japan closely reflects the shape, and, especially, the mountainous character of the country. There is no close network of lines except locally; the pattern as a whole resembles a ladder rather than a web. The total mileage of railroad in Japan proper (excluding street railways) in 1938 was 15,624, of which about 45% was in Southwest Japan.

The rugged interior makes railroad construction difficult

* Some variations between spellings of place names in the text and maps may be found. Reference should be made to the Gazetteer.

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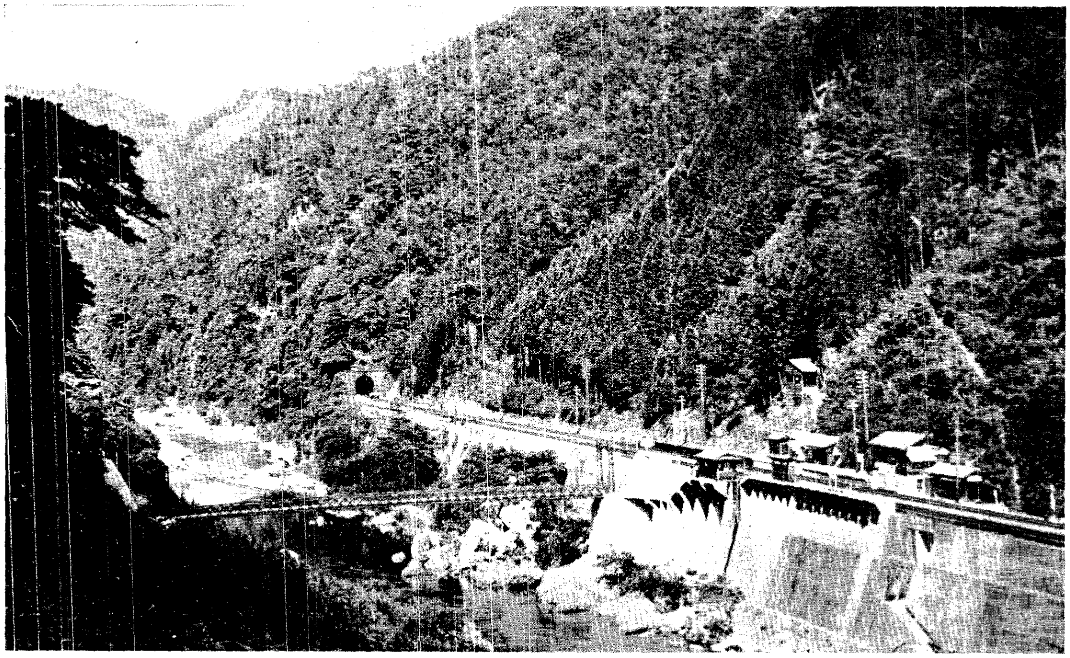

FIGURE VII - 1. *Kyōto.*
Railroad and tunnel in gorge of the Hozu-gawa (river), Sanin line. Approximately 35° 15'N, 135° 17'E.

and costly on all the islands. There are no long valleys parallel to the mountain axes, that might serve as corridors for rail lines; the longest such valley, in northern Honshū, extends only about 90 miles. Consequently, through routes tend to follow the coasts, and often run for many miles almost at the shore line. Even where they take a more direct course, as across the bases of peninsulas, they usually have branch lines or loops along the shore. Thus, there are few stretches of coast that are not skirted by a railroad. The Japanese government apparently attaches great importance to these peripheral lines, as they have been considerably extended in recent years, notably on Ise Peninsula and Shikoku.

All the most important cities of Japan are located on or near tidewater, and are thus directly connected by lines along either the east or west coasts. On Kyūshū and Honshū, the east and west coast lines are joined at both ends, forming complete circuits around the islands. Many transverse connections and alternative routes through the interior highlands have been built in the last 20 years. They not only serve as detours when sections of the main lines are closed by earthquakes, floods, and landslides, but also increase appreciably the capacity of the whole system.

Only a few routes, however, are of major importance. By far the most important line is the one connecting the 6 largest cities of Japan—Tōkyō, Yokohama, Nagoya, Kyōto, Ōsaka, and Kōbe—and its extension to Shimonoseki. From Tōkyō to Kōbe, this route is called the Tōkaidō line; from Kōbe to Shimonoseki, the Sanyō line. At Shimonoseki, an undersea tunnel to Moji now connects the railroad system of Honshū with that of Kyūshū. Disruption of the Tōkaidō-Sanyō line, or any considerable part of it, would be a major inconvenience to Japanese war economy.

The second major connecting link is the Sanin line, extending from Kyōto to Shimonoseki via the north coast, and is the chief connection between the cities of the Japan Sea coast of southwestern Honshū and the densely populated industrial regions in and around Kōbe, Ōsaka, Nagoya, and Tōkyō. It also offers an alternative route between Kyōto and Shimonoseki, but is longer and has a much lower traffic capacity than the Tōkaidō-Sanyō line.

The 2 most important transverse lines are those that connect the Tōkyō and Ōsaka-Kōbe regions, respectively, with the west coast. The significance of these lines has been enormously increased since the Japanese attack on China, and the war in the Pacific, with its attendant shipping crisis, has strained their capacity to the utmost. They are the chief routes by which raw materials and food from Korea and Manchuria reach the industrial centers of the Tōkyō and Ōsaka-Kōbe regions. Manufactured goods and war materials travel in the reverse direction, and any intensification of military activities west of the Japan Sea will make even greater demands on these cross-island routes.

The more direct lines from Tōkyō to the west coast lie outside the area of Southwest Japan, and will not be discussed here. From the Ōsaka-Kōbe and Nagoya districts, the shortest cross-island routes lead to the port of Tsuruga, and these lines converge at Maibara, on the Tōkaidō line, near the northern end of Biwa-kō (lake). Owing to the congestion of traffic at Maibara and on the short line from there to Tsuruga, as well as on the Tōkaidō line itself between Kyōto and Maibara, plans for a new railroad from Tsuruga to Kyōto were made several years ago. This line has been reported to be at least partially completed, but its location is not known. According to some reports, it is an electrified line paralleling the old route, while

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other statements indicate that it joins the line along the western shore of Biwa-kō, thus leading directly to Ōtsu, near Kyōto. Official reports have announced the completion of 2 long tunnels on the new route. It is possible that both routes have been built.

On the island of Kyūshū, the main lines connect Moji with Nagasaki and Kagoshima respectively, diverging at Tosu, 67 miles southwest of Moji. The Kagoshima line follows the west coast for about 125 miles. These 2 routes constitute the life line of the island.

The east coast is served by the Nippō line, which may also be used as an alternative route between Moji and Kagoshima. Large quantities of military supplies destined for the Philippines and the South Pacific move over the lines to Kagoshima.

A small network of railroads serving important coal fields in northeastern Kyūshū connects with the Kagoshima main line at Orio, 19 miles west of Moji, and also at Kokura. Coal from these fields now moves by an all-rail route through the undersea Moji-Shimonoseki tunnel to the industrial centers of Honshū.

The railroads on Shikoku are of secondary importance, and are less well equipped and maintained than those of the other islands.

The routes described in the foregoing paragraphs are the most important and direct lines, upon which the efficient functioning of the Japanese economy is closely dependent. Their disruption would seriously cripple nearly all forms of industry, particularly heavy industry, but would not completely stop rail traffic between many of the most vital centers, which can, in most cases, be reached by alternative routes. Most of these routes are longer and have a much lower traffic capacity than the main lines; they usually traverse rugged country, with steep grades and numerous tunnels and bridges, and their roadbeds and tracks are generally inferior to those of the more direct lines. Nevertheless, some of them are important enough to warrant brief mention, and are listed below:

Between Tōkyō and Nagoya: Chuo line, via Kōfu, Shiojiri, and Tajimi.

Between Nagoya and Ōsaka: Kansai line, via Kuwana, Kameyama, and Kizu.

Between Ōsaka and Tsuruga: Hankaku line, via Sanda, Sasayama, Fukuchiyama, and Maizuru.

Between Yatsushiro and Kagoshima: Hisatsu line, via Yoshimatsu, Kurino, and Kokubu.

The numerous cross-island lines and short connecting links that have been built in recent years make it possible to by-pass other sections of the main routes, often for considerable distances, but few of these secondary lines can handle heavy traffic.

According to Japanese reports, work is actually underway on the building of a standard gauge (4′8½″) main line, approximately paralleling the Tōkaidō and Sanyō lines but running farther inland. Work has been completed on the Osakayama tunnel (1,850 or 2,340 meters long) and the Higashiyama tunnel. These tunnels are variously reported to be between Kyōto and Otsu, or in Shizuoka-ken. This line will have 5 times as many tunnels as the present main line, and is intended to carry "bullet" trains.

B. Administration.

Since the early years of the present century, the Japanese government has been steadily increasing its control over the railroads of the country. In 1938, it owned and operated 72% of all the railroad mileage, excluding urban tramways (street railways), many of which were owned by municipalities. During the last few years, an extensive program for the purchase of private lines has been carried out, and today a much larger proportion of the total mileage is comprised in the Imperial Government Railways.

All railroads used for "general traffic", and particularly through traffic, are owned by the State. Private lines are restricted to local and interurban service; their function is to act as feeders to the State railways and to supplement their facilities, especially in newly developed areas and in the expanding suburbs of big cities. For this purpose, they have frequently been granted subsidies by the State.

A distinction is made between "local railways" and "private railways," although both are under private ownership. "Local railways" correspond to the formerly numerous interurban lines in the United States; "private railways" commonly service mines and smelters, timber tracts, and gravel or clay pits.

In 1920, the Imperial Government Railways were given the status of a department of state. A cabinet officer, the Minister of Railways, acts as president of the system and administrative head of the Central Office in Tōkyō. Actual administration, however, is decentralized. For operating purposes, the whole system is divided into 8 regions, as follows: Tōkyō, Nagoya, Ōsaka, Hiroshima, Moji, Niigata, Sendai, and Sapporo. Each of these regions is in charge of an officer (director), whose responsibilities and duties are much like those of a regional superintendent on a large American railroad; he has final authority within his region on all matters except those involving broad policy, which must be referred to the Central Office.

Each regional administration comprises 7 departments and a number of district offices, and has its own engineering staff. The departments are:

General Affairs, including staff.
Operating.
Traffic.
Mechanical Engineering.
Electrical Engineering.
Finance.
Marine.

The regions are divided into operating and right-of-way districts. Workshops and electric power plants are also supervised by district offices. Railway schools, hospitals, and hotels, on the other hand, are managed by the regional offices.

Locomotive running is under the operating department, maintenance under mechanical engineering. Locomotives, passenger cars, and electric motor cars are allocated to each region and maintained by the regional departments, but freight cars of all descriptions are pooled.

The Central Office not only manages the Imperial Government Railways but also supervises local railways, tramways, and other forms of land transportation. Until recently, it consisted of 8 departments, each of which was divided into sections. These departments were:

Minister's Secretariat, which handled official documents, personnel, labor, health, welfare.
Local Railways.
Traffic and Operation.
Construction.
Maintenance and Improvement.

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Mechanical Engineering.
Electricity.
Finance and Purchasing.

The Central Office also controls local operations in Tōkyō, including the Tōkyō Railway Hospital.

In addition, 3 advisory bodies are directly responsible to the Minister of Railways:

1, A railway council, consisting of the Minister, as president, and 30 other members. The members include government officials from other than the Railways administration, such as Vice-Ministers of Home Affairs, Finance, and War, members of the Diet, and others appointed on recommendation of the Minister of Railways. The Minister is required by law to consult the Council on such matters as new developments, authorization of local railway construction, absorption of local lines by the State, electrification, and selection of important motor traffic routes to be operated by the State.

2, A committee on rates and fares, consisting of 12 members appointed by the government.

3, A council on tourism, made up of 60 members.

In 1942, as part of a general program of simplification of civil administration, the Ministry of Railways reduced the number of railway departments from 8 to 4, the number of department offices from 236 to 169, and the number of district offices from 110 to 70.

The finances of the Imperial Government Railways were originally part of the general State budget, but were made an independent account in 1909, and have so remained. It is required that all ordinary expenses be met from receipts. Special provisions are made to cover the costs of improvements and new construction when profits are not sufficient for this purpose. Such capital expenditures were formerly met by special public loans; more recently, they have been provided for by a reserve of 20,000,000 *yen* set apart every year on the railway account or from the government general account.

All officials and employees of the Imperial Government Railways are classified in groups sharply distinguished according to rank. High officials, appointed directly by the Emperor, form a small *tyokunin class,* including vice ministers, directors, councilors, and a few engineers and inspectors general. Administrative and technical officials of lesser rank, such as secretaries and most engineers, who are appointed by the government with the Emperor's approval, are included in the *sonin* class. These 2 groups together constitute the Koto-kan. Clerical employees and assistant engineers are of *hannin* rank. Foremen belong to the *tetsudosyu* class, about the *koin* rank of skilled laborers. The lowest and largest group is the *yonin* class.

Salaries and wages paid are extremely low by American standards, ranging from 4,700 *yen* per year for the *tyokunin* rank to less than 600 *yen* for *yonin* workers.

Various administrative changes have been made in the Japanese transportation system as a result of problems created by the war. In October 1943, the Imperial Government Railways became a part of the newly established Ministry of Transport and Communications, which also includes shipping. The object is to bring about better coördination between all forms of transportation and communication.

In general, the Japanese railways have been effectively and efficiently operated. They have been virtually free from politics, and high technical standards have been consistently maintained. Employees are noted for their loyalty, courtesy, and strong sense of responsibility. Much emphasis is placed on punctuality; before the war, trains were rarely late. The total number of employees of the Japanese State Railways in 1937 was about 230,000. In 1942, the number had increased to 380,000. About 60% of the present employees are women.

C. Track and right-of-way.

The standard gauge of the Imperial Government Railways is 3′6″. This gauge is also used on most of the local railways, but a considerable number of these have a 4′8½″ gauge, while still others use 4′6″ or 2′6″.

All but a few lines are single-tracked. In 1940, 18,352 kilometers (11,395 miles) of the government lines were single-track, out of a total of 20,501 kilometers (12,740 miles) operated. There were 1,945 kilometers (1,207 miles) of double-track, and 204 kilometers (127 miles) of quadruple-track. The chief length of double- and multiple-track is the Tōkaidō-Sanyō line, which has 4 tracks near Tōkyō and between Kyōto and Kōbe (FIGURE VII - 2), and 2 tracks the rest of the 680 miles between Tōkyō and Shimonoseki. The Kagoshima line is double-track from Moji to Tosu (67 miles) and possibly to Kurume. There are numerous double-track local electric railways, especially in the Tōkyō and Ōsaka-Kōbe region (FIGURES VII - 3 and VII - 4).

Sidings are located at short intervals on all single-track main lines.

Much care is given to the protection of the right-of-way, although it is generally not fenced (FIGURES VII - 2 and VII - 5). All stations are closed, and crossings are guarded. The frequency of earthquakes and heavy rains and the shattered character of much of the surface rock make necessary special precautions against landslides, caving of banks, and other hazards. Cuts and fills are carefully graded and sown with some sort of grass whose roots will hold the soil. Drainage ditches are lined with stone or cement. Embankments and the slopes of cuts are held up by elaborate and solidly built stone walls (FIGURES VII - 6 and VII - 7), and concrete blocks are often inserted into the soil.

(1) *Grades and curves.*

Japanese railroads abound in steep grades and sharp curves. About ⅔ of the total mileage is on grades, and about ⅓ on gradients of over 1%. The maximum grades on the steeper

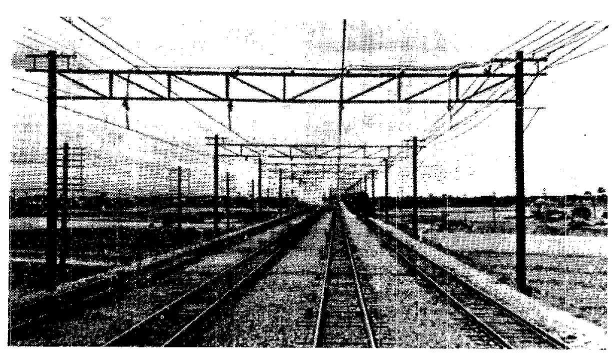

FIGURE VII - 2. *Ōsaka.*
Electrified section of Tōkaidō main line between Kyōto and Ōsaka.

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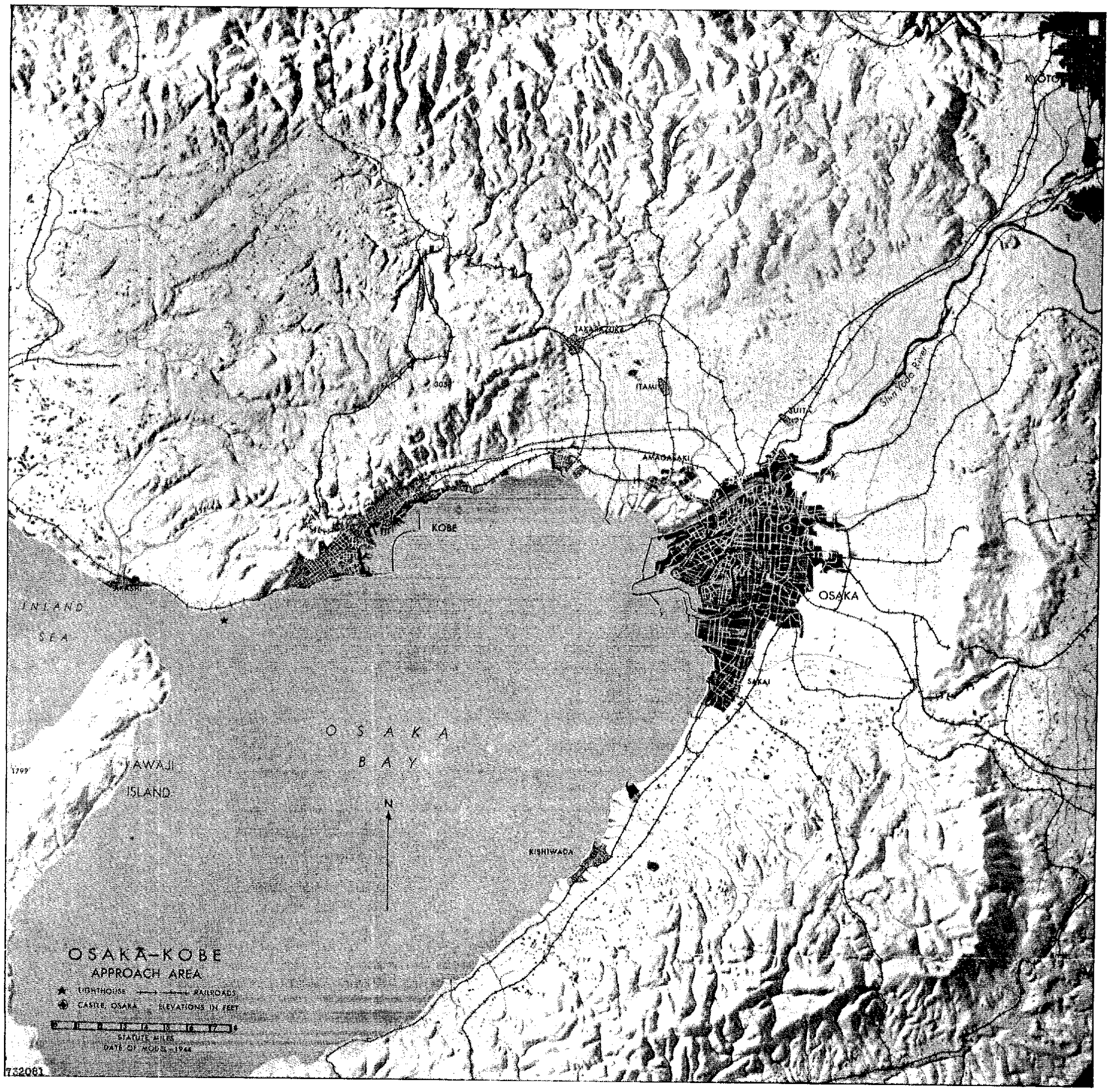

FIGURE VII - 4. *Relief of the Kyōto-Ōsaka-Kōbe area.*

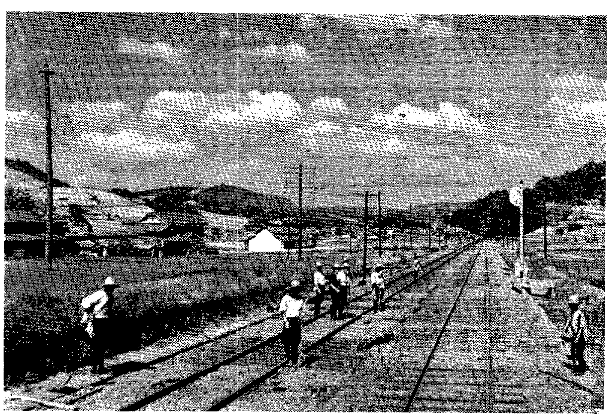

FIGURE VII-5. *Vicinity of Itsuku-shima, Hiroshima prefecture.*
Sanyō main line. Color light signal at right.

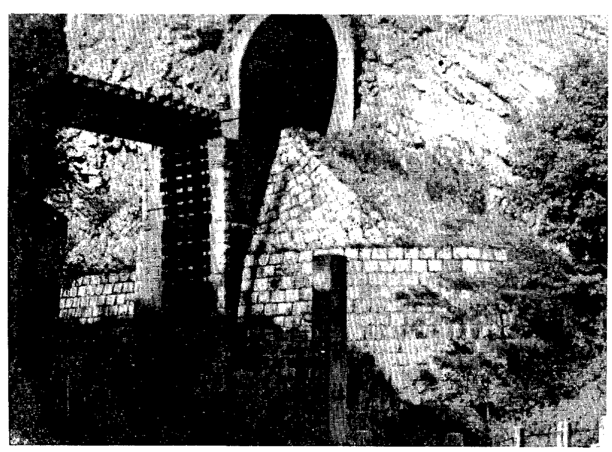

FIGURE VII - 6. *North of Nagano.*
Masonry retaining walls, bridge, and tunnel on the Chuo line.
Approximately 36°40′N, 138°10′E.

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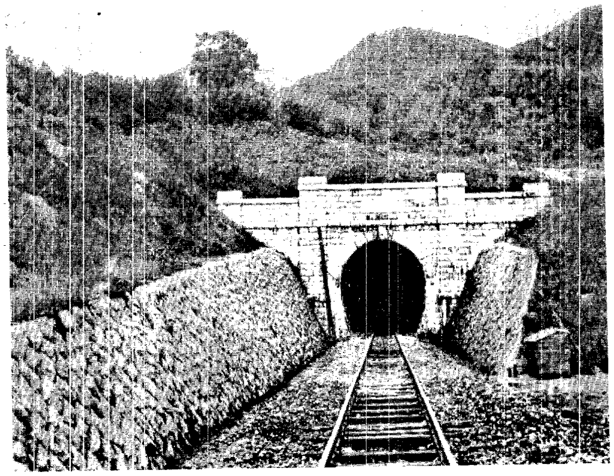

FIGURE VII - 7. *Niitsu, Honshū.*
Masonry retaining walls and tunnel. Typical construction.

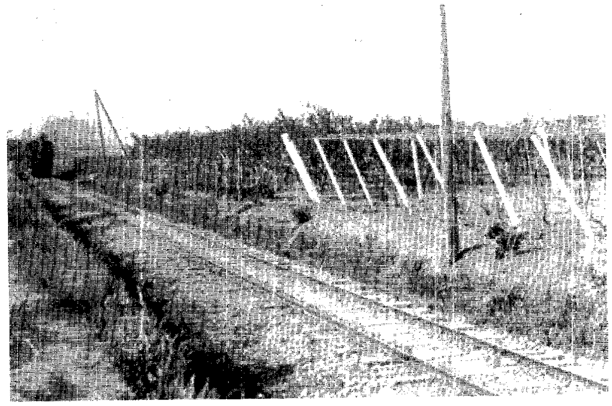

FIGURE VII - 8. *North of Hamamatsu.*
Branch line track, showing light rails and lack of ballast.

lines are 2½%, with short stretches as high as 3.3%. Special mountain lines have even steeper slopes.

In 1929, nearly 30% of Japanese railroad mileage was on curves, and, as most of the lines constructed since that time run through rugged country, the proportion of curves today is probably larger. The minimum radius of curvature is 300 meters (990 feet), but there are some exceptions to this rule; curves of 858-feet radius occur on the Usui Pass route in central Honshū, and one curve on Hokkaidō has a radius of 594 feet.

(2) *Ties.*

The standard dimensions for ties (sleepers) are 7 feet by 8 inches by 5½ inches, though some ties 6 feet, 6 inches long are in use. On switches and turnouts, ties are 9 feet by 5½ inches in cross-section and 7 feet, 2½ inches to 13 feet, 1½ inches long. Tie spacing varies from about 2 feet to 3½ feet; on main and important lines it is 2 feet, 7½ inches; on sidings and side tracks 2½ feet to 3½ feet and on bridges 2 feet, 2 inches.

Japanese woods are commonly used, principally chestnut, but also some pine, *shii*, and Nara oak. For switches, crossings, and bridges, *hinoki* and *hiba* (redwood and cypress) are favored. Timber from Indochina, probably ironwood, has recently been imported for ties. On main lines, most of the ties are creosoted; elsewhere, treated and untreated ties are often interspersed. When softer woods such as pine and beech are used, they are usually creosoted. Metallic ties have been used experimentally on bridges, and at switches and crossings.

(3) *Rails.*

The government railroad system has adopted a standard rail, 40 feet long and weighing 100 pounds per yard, for main express lines, but it has probably not yet entirely replaced the old standard type, which is 33 feet long and weighs 75 pounds per yard. On other main lines, 68-pound rails are often used, and on less important lines 60-pound and 54-pound types may be found (FIGURE VII - 8). The 100-pound rails are flat-bottomed, with Pennsylvania cross-section; lighter rails include ASCE and old British Standard types.

Welded rails have also been introduced and are generally used in tunnels. They are from 20 to 25 meters (67 feet to 83 feet) in length.

Rails are usually spiked directly to ties (FIGURES VII - 2, VII - 5, VII - 8, and VII - 9), but on bridges and in tunnels, screw spikes and tie plates are used. The joints are not staggered. In tunnels, they are welded.

By American standards, Japanese track construction appears flimsy, but it should be remembered that motive power and rolling stock are much lighter in weight than on American railroads. Until recently, very little track machinery was used, so that a large amount of hand labor was necessary for maintenance work. This condition probably still prevails.

(4) *Signals.*

All trains are operated by the block system. In 1937, automatic block signals had been installed on 780 miles of line, of which 204 miles were electrified and 576 miles steam-operated The total number of such signals was 4,383, including 3,971 of the color-light type (FIGURE VII - 5) and 412 of the sema-

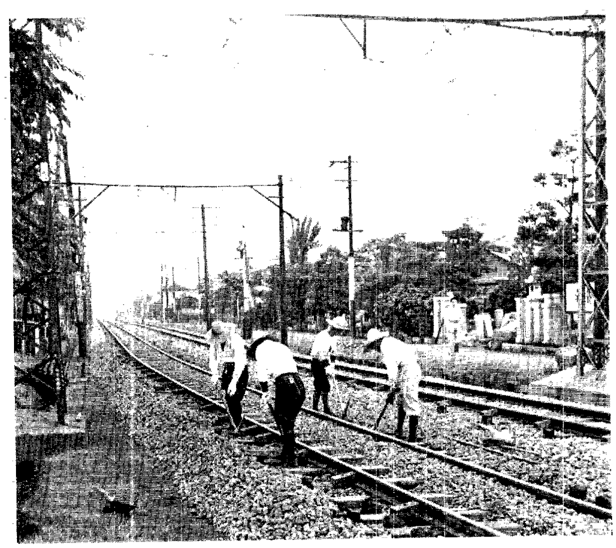

FIGURE VII - 9.
Main line, roadbed and track, showing gravel ballast and use of wood blocks as added protection against side thrust on curve.

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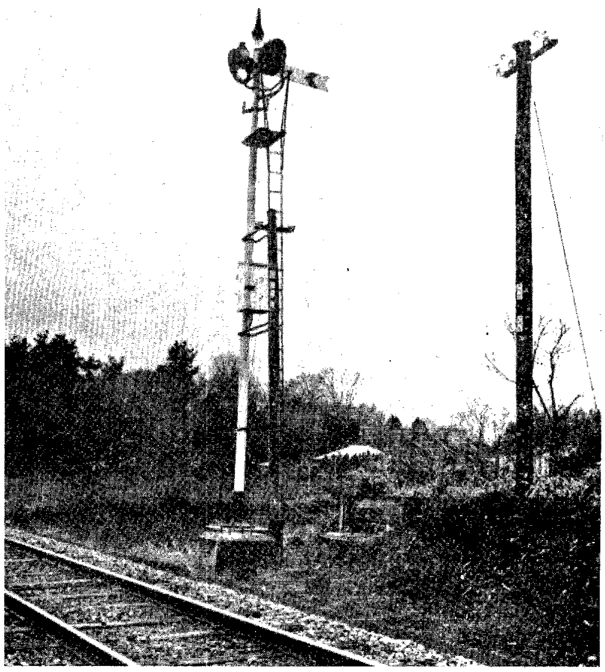

FIGURE VII - 10. *Yotsukaido.*
Electric semaphore-type signal on the Imperial Government Railways. About 1929.

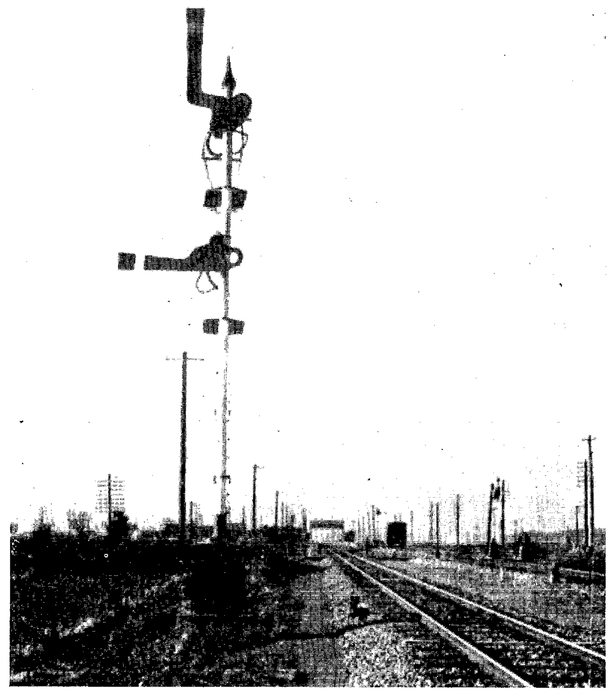

FIGURE VII - 11. *Inage.*
Automatic semaphore-type signals. About 1929.

phore type (FIGURES VII - 10 and VII - 11). The installation of signals has been considerably extended since 1937.

Signals and switches are interlocked, either mechanically or electrically. Automatically operated power switches are in use at only a few of the large stations.

(5) ***Roadbed and ballast.***

The usual width of roadbed is 16 feet on single-track lines. Except on the most important lines, ballast is not generally used; the ties are laid on or in the natural soil. Gravel is the most common type of ballast (FIGURE VII - 9). Crushed stone is less common, but is extensively used in metropolitan districts. River gravel is used wherever it is readily available; elsewhere, pit gravel is used instead. Sizes range from ½ inch to 2⅞ inches.

Where the grade follows the natural slope of the land, the ballast is laid directly on the top soil, except in regions of severe cold, where a rubble sub-base is used to prevent upheaval of the soil by frost. Tunnels over 1.5 kilometers (.9 mile) long on new lines have concrete floors, and rails are carried on wood blocks set in the concrete.

D. Bridges and tunnels.

Both bridges and tunnels are extraordinarily numerous on the railroads of Japan. In 1930, there were almost 29,000 bridges on the government railroads alone, and the number, as of December 1943, is estimated to be nearly 44,000, with a total length of about 450 miles and an average length of about 55 feet. This gives an average of 370 bridges per 100 miles of line, or nearly 4 per mile. Comparable data for tunnels are not available, but in 1937 there were 1,200 railroad tunnels in Japan, with an aggregate length of 435 miles. A number of long tunnels have been completed since that time.

Despite the existence of a variety of bridge types, over 95% of all railroad bridges in Japan are simple plate or truss girders, on piers that are now generally of reinforced concrete, faced with concrete blocks or masonry. Arches constitute less than 3% of the total length of bridges on the Imperial Government Railways. Suspension, lift, and other types are very rare. There are practically no wooden bridges (FIGURES VII - 12 to VII - 21 and TABLES VII - 1 and VII - 2).

The following characteristics of Japanese railroad bridges are notable:

1. Comparatively moderate impact and load strains, owing to light, narrow-gauge rolling stock.
2. Special precautions against earthquakes, shown in the almost universal use of steel and reinforced concrete, and special care in piers, abutments, and abutment wings.
3. Special attention to bridge-pier foundations, because of many gorge-like valleys that carry little water normally, but become raging torrents during recurrent heavy rains.

Japanese railroad tunnels are also characterized by certain special features:

1. Aggravated problems of ventilation and protection against sulphur acids, resulting from numerous locomotive passages, sulphurous coal, and heavy grades.
2. Latent weaknesses produced by minor earthquakes of the everyday variety. These often cause serious damage when stronger earthquakes occur.
3. Old, undersized tunnels still remaining on some provincial and local lines, which will not admit modern passenger cars. The present minimum clearance is 15 feet above rail bed, and 15 feet width.

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TABLE VII - 1.
SELECTED RAILROAD BRIDGES.
(This table includes only the most important and vulnerable bridges; most of them are at least 500 feet long. Other bridges are listed in the descriptions of individual lines. Route letters and bridge numbers refer to FIGURE VII - 58.)

ROUTE	BRIDGE	RIVER	LOCATION	LENGTH (feet)	STRUCTURAL FEATURES ("2x56'" means 2 spans, each 56' long)	REMARKS
A	1	Chikugo	Kurume	1,670	Has 1 lift span	Shown in Figure VII-15.
A	2	Shira	Kumamoto			Bridge No. 16 about 1 mi. N.
A	3	Kuma	Yatsushiro	500		Figure VII-19.
A	4	Sendai	Sendai			
B	5	Shimono	Nagasaki			
B2	6	Chikugo	Between Saga and Yanagawa	1,690	15 spans 1x80' plate girder lift span 2x156' steel truss 9x121' deck plate girder 1x74' deck plate girder 1x53' deck plate girder 1x43' deck plate girder	Reinforced concrete piers with well foun dations. Lift span 48 tons; maximum lift rise 76.6'.
C	7	Kuma	Kamase, about 8 mi. SSE of Yatsushiro			Bridge in narrow valley, at entrance to tunnel No. 6.
C	8	Kuma	Hitoyoshi			
C	9	Sendai	Kurino			
D	10	Oyodo	Miyazaki	1,700	18 spans, stone or concrete arches.	Figure VII-14.
D	11	Hitosuse Komaru	Obuchi Near Takanabe	1,600 2,000		2 bridges, about 6 mi. apart.
D	12	Gokase	Nobeoka	1,200		
D	13	Ono Otozu	Tsurusaki			Several bridges over mouths of Ono and Otozu. 1 bridge 1,000'.
D	14	Yasaka	West of Kitsuki			7 bridges and 4 tunnels in a 6-mile stretch of track west of Kitsuki. All bridges of plate girder type; longest is 385' long, with 7 spans.
D	15	Yakkan	Nagasu	1,000	14 spans, plate girder, with masonry abutments.	
F	16	Shira	A few mi. NE of Kumamoto	500	Balanced steel arch, spanning deep ravine. Height above water, 193'. Main span, 300'.	Figure VII-20. Said to be highest bridge in Japan. Another bridge about 1 mi. S of Kumamoto; near bridge No. 2.
G	17	Ota	Hiroshima	"Long"		3 other bridges nearby.
G	18	Sasagase	4 mi. SW of Okayama, on line to Tomano	600	8x71' spans, steel truss. Stone abutments.	4 other bridges on this line between Okayama and Tamano.
G	19	Asahi	Okayama			Described as "large bridge."
G	20	Ichi	Himeji			"Long bridge."
G	21	Kako	Kakogawa			
G	22		Kōbe-Ōsaka Area		7 railroad bridges across Yodogawa at Ōsaka. Main bridge 540'; steel truss, on 2 concrete abutments, 32' wide, 30' high, 80' above river.	4.8 mi. of elevated main line in Kōbe, 1½ mi. in Ōsaka (FIGURE VII - 21).
G	23	Seta	E of Ōtsu	"Long"	Plate girder.	FIGURE VII - 13. Swift current reported.
G	24	Ibi	Ogaki	3,000	15 spans, plate girder. Caisson piers.	
G	25	Nagara			Steel truss.	FIGURE VII - 17.
G	26	Kiso	Gifu	2,830	14x200' spans, plate girder, Caisson piers.	
G	27	Kariya, Chita-wan (bay)				2 bridges about 2 mi. apart, both long.
G	28	Hamanaka	10 mi. W of Hamamatsu		Plate girder.	2 bridges separated by small island.
G	29	Tenryu	6 mi. E of Hamamatsu	4,000	19x200' spans, Parker steel truss.	One of the longest bridges in Japan. A causeway 1 mi. long leads up to bridge. Carries telephone cable.
K	30	Shonai	Nagoya			2 bridges, 1½ mi. apart.
L	31	Ibi, Kiso	Near Kuwana	1,875 2,880	9x200' spans. 14x200' spans, multiple web Warren truss.	2 bridges, 3 mi. apart.
L	32	Miya	Uji-Yamada	1,450		
L	33	Kizu	Kizu	550	60° "skew" Pratt truss, 5 spans. 1x203' x 2x102' x 2x71' Designed for load of 1 ton per foot length of span. Piers 60' above low water. High steel viaduct.	Another bridge at Kizu; reinforced concrete viaduct on line to Kyōto.
H	34	?	Amar..be, near Kasumi			FIGURE VII - 18. Tunnel at one end of bridge. Other bridges and tunnels in this section.
H	35	Shin	West of Shinji	500	6x81' spans, steel girder, masonry piers.	2 bridges, about 3 miles apart. A 3rd bridge 1½ mi. W.
		Hii	West of Shinji	1,100	Steel girder, masonry piers. 21 spans: 11x40'x10x71'	
H	36	Gōno	Gōtsu			
H	37	?	Takatsu			Long bridge.
P	38	Yoshino	3½ mi. SE of Awa-Ikeda	1,600		
R	39	Yoshino	Near Tokushima		Steel truss.	"Very large" bridge. (Figure VII-16).
R	40					7 bridges in 15 miles.

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TABLE VII - 2.
SELECTED RAILROAD TUNNELS.
(Route letters and tunnel numbers refer to FIGURE VII - 58. See description of individual lines for other tunnels.)

ROUTE	TUNNEL No.	NAME	LOCATION	LENGTH (feet)	REMARKS
A,G	1	Kammon	Between Moji and Shimonoseki	About 8,000	Undersea tunnel, connecting Honshū and Kyūshū islands. Exact location unknown, but believed to be from Hikō-shima (island) to a point about 3 mi. S of Moji, with a concrete viaduct extending from Shimonoseki to the N entrance of the tunnel on Hikō-shima (island). The tunnel is 24′ in diameter and 124′ below sea bottom. It is built of steel rings, each made up of 14 segments. Tunnel cemented inside, ballasted on bottom, and carries single-track line.
A	2	Shashiki (Shashikitaru)	Shashiki	4,800	
A	3	Tsunagi	5½ mi. NE of Minamata	4,400	
A	4	Utazaka	3 mi. NE of Minamata	About 2,000	
A	5		Between Akune and Sendai		17 tunnels in this stretch. Lengths vary from 300′ to 1,200′.
C	6		8 mi. SSE of Yatsushiro	1,300	Tunnel at S end of bridge across Kuma-gawa.
C	7				Several short tunnels in this stretch.
C	8		4 mi. SE of Hitoyoshi	2,500	Tunnel in spiral curve.
C	9	Yatake No. 1		6,900	In hard rock, on 1.25% grade.
D	10		NE of Miyakonojō		7 tunnels in 12 miles, including Aoidake, 5,017′ long.
D	11		5 mi. N of Nobeoka		Short tunnel through mountain spur at river.
D	12		Between Saegi and Tsurusaki		28 tunnels in 40 miles.
D	13		N of Saeki	6,000	Exact location unknown.
D	14	Sashi	N of Saeki	4,700	Exact location unknown.
D	15			About 2,000	3 other tunnels in 6-mile stretch west of Kitsuki.
E	16	Mizuwake		6,000	2 other tunnels within 1 mi. of E end of Mizuwake.
G	17	Fukuda	5 mi. W of Asa	3,800	Another tunnel at Asa.
G2	18		Near Kure	8,600	
G	19	Higashiyama Osokayama	Between Kyōto and Anju Between Anju and Ōtsu	6,185 7,750	2 tunnels, about 3 mi. apart. Both are single-track, brick-lined, ventilated.
H	20	Kameyama No. 1	Near Saga, 6 mi. NW of Kyōto		2 tunnels close together.
H	21	Kameoka	Kameoka, 13 mi. NW of Kyōto		1 other tunnel.
H	22		About 7 mi. N of Toyooka		3 tunnels.
H	23		Near Hamasaka		5 tunnels.
H	24		Near Gōtsu		16 tunnels in 11 miles.
N	25	Aoyama		11,440	On electric line. 2 other tunnels close by.
M	26	Yanegase	18 mi. N of Maibara	4,500	Semi-circular brick arch, 15.5′ high, masonry side walls. On 2.5% grade.
R	27		Between Ikeda and Gomen		26 tunnels in 40 miles.

E. Electrification.

Although steam locomotives furnish most of the motive power on Japanese railroads, in the vicinity of Tōkyō, and in the Kyōto-Ōsaka-Kōbe and Nagoya regions, a very large proportion of the rail traffic is moved over electrified lines. Nearly all of the total of 240 miles of electrified lines operated by the Government Railways in 1937 is in the first two of these districts; 23 miles are in the Hiroshima district. The Tōkaidō line has been electrified between Akashi and Ōtsu, east of Kyōto (64 miles), though many steam trains, especially freights, are still operated over it. There are 3 interurban electric lines between Ōsaka and Kōbe, and 2 between Ōsaka and Kyōto, in addition to the 4-track Tōkaidō line. From these cities, especially, Ōsaka, electric railroads radiate in many directions (FIGURE VII - 3). The longest is the 60-mile Sangū line to Uji-Yamada. These lines were privately owned and operated in 1938, but, since then, some or all of them have probably been purchased by the government.

Other important electric railroads are shown on FIGURE VII - 58.

The electrified section of the government line operates with direct current at 1,500 volts. Power is transmitted by underground cables from generating stations at 11,000 or 22,000 volts alternating current to substations, where it is changed to 1,500 volts direct current and distributed to single catenary overhead wires (FIGURE VII - 1). Local traffic is handled by multiple unit motor car trains and through express trains, and freight trains by electric locomotives, though steam trains still operate over the Kyōto-Kōbe section. Generating stations are now owned by the government.

Gasoline and gasoline-electric cars were formerly operated on branch lines and on some local railways, but, because of the fuel situation, most if not all of these, as well as diesel engine equipment, are believed to have been withdrawn from service.

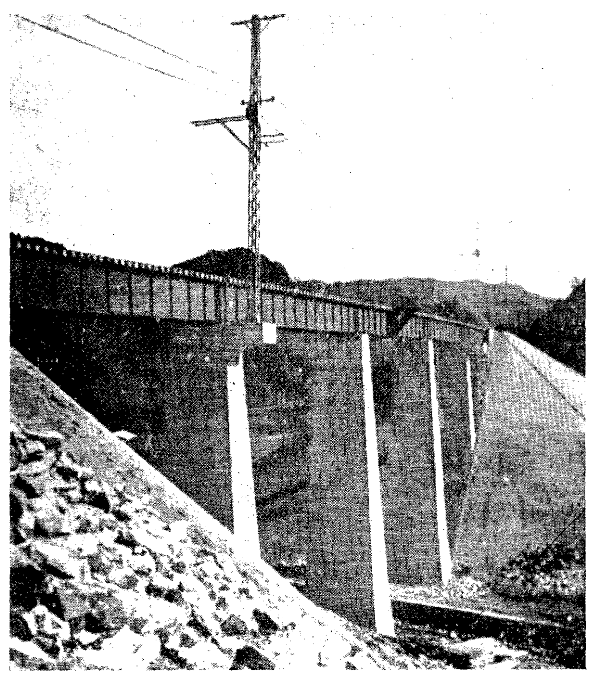

FIGURE VII - 12. *Vicinity of Aoyama-tōge, Mie prefecture.*
Bridge on Sangū electric railway. Approximately 34°22′N, 136°15′E. 1931.

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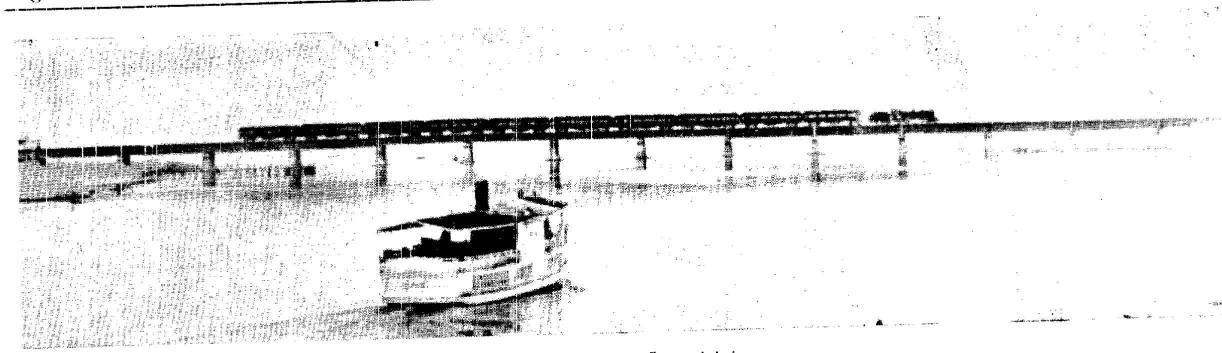

FIGURE VII - 13. *Ōtsu vicinity.*
Bridge of the Tōkaidō line over Seta-gawa (river) at Biwa-ko (lake). Approximately 35° N, 135° 50′E.

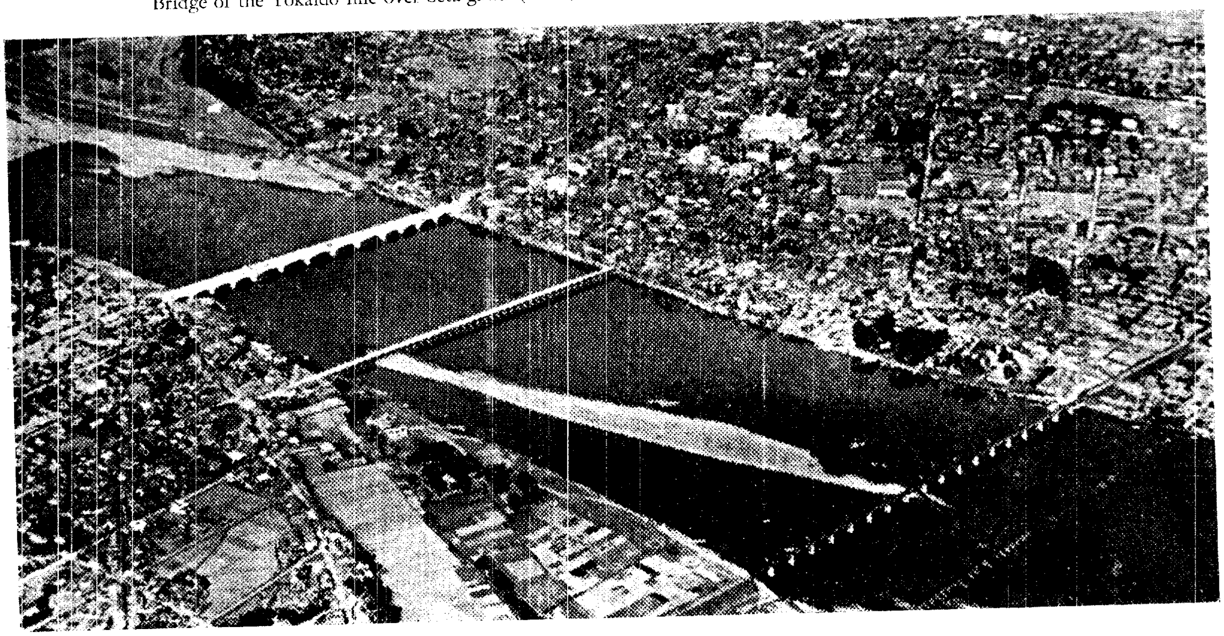

FIGURE VII - 14. *Miyazaki.*
Airview showing railroad bridge over Ōyoda-gawa (river) in foreground Nippō line). Bridge about 1,700 feet long with 19 stone or concrete arches.

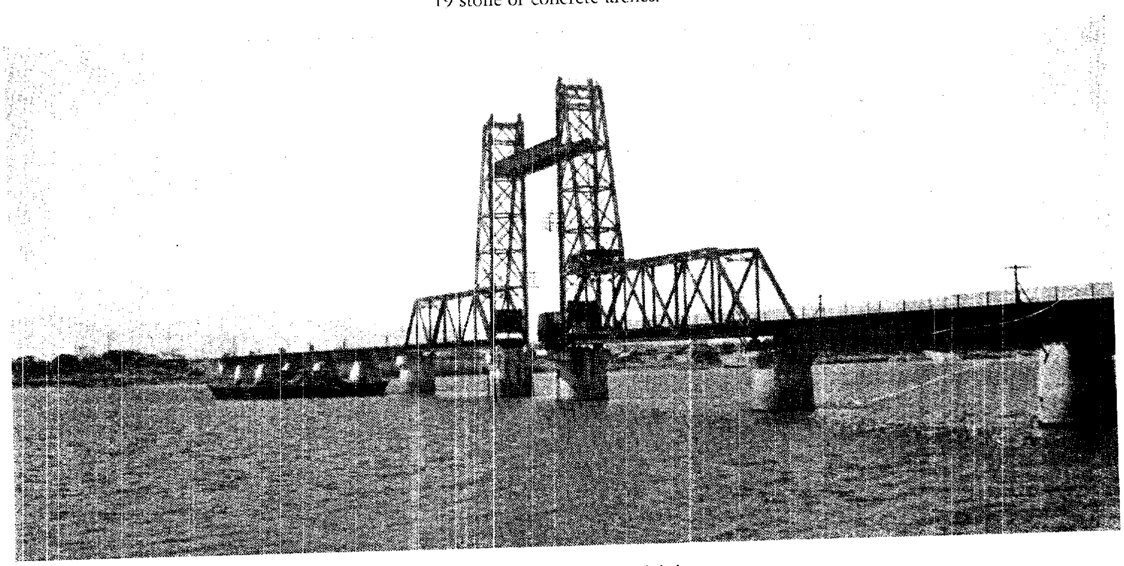

FIGURE VII - 15. *Kurume vicinity.*
Railroad lift bridge 1,670 feet, long over Chikugo-gawa (river) at Kurume. About 1937.

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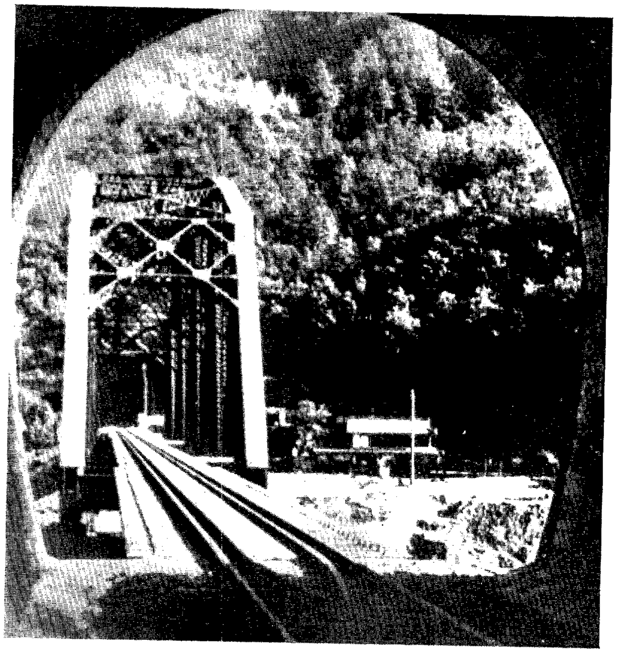

FIGURE VII - 16. *Tokushima.*
Railroad bridge over Yoshino-gawa (river), Shikoku.
Approximately 34°04′N, 134°33′E.

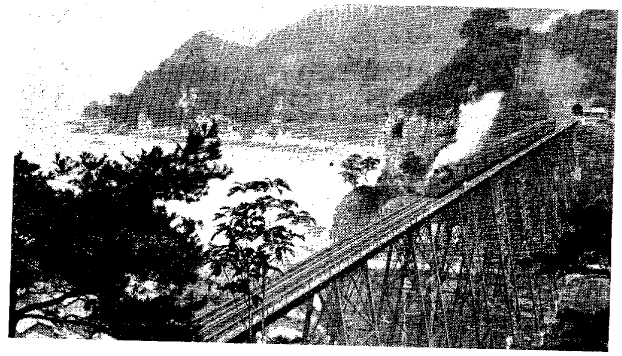

FIGURE VII - 18. *Amarube vicinity.*
Railroad viaduct on the Sanin line. Approximately
35°39′N, 134°33′E. 1927.

FIGURE VII - 19. *Yatsushiro.*
Railroad bridge over Kuma-gawa (river) on Hisatsu line, during
construction. Tunnel entrance at end of
bridge. Before 1932.

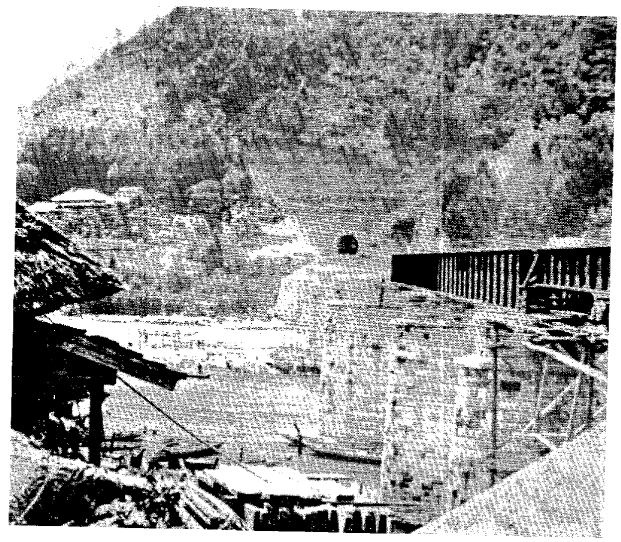

FIGURE VII - 17. *Gifu.*
Airview showing railroad bridge over Nagara-gawa (river).

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FIGURE VII - 20. *Kumamoto.*
Steel arch bridge over Shira-gawa (river) on Hōhi line. Length of main span, 300 feet. Height above water, 193 feet. Approximately 32°50′N, 130°54′E. 1930.

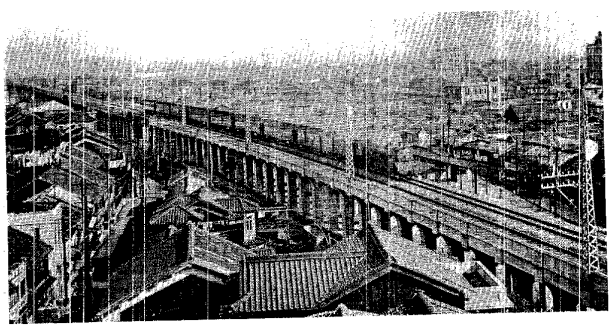

FIGURE VII - 21. *Kōbe.*
Elevated main railroad line. The elevated portion is 4.8 miles long. Before 1932.

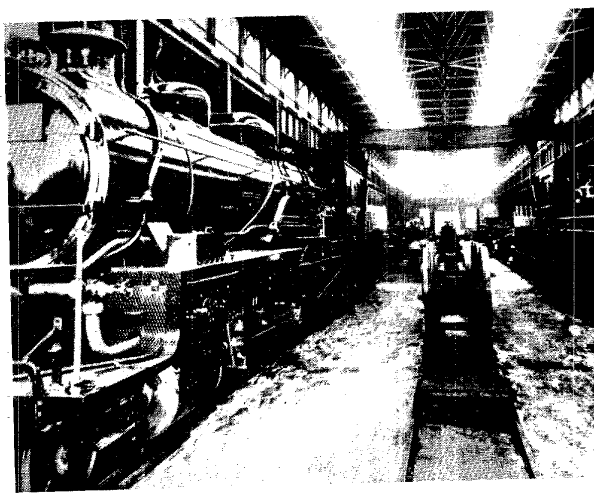

FIGURE VII - 22. *Kōbe.*
Locomotives under construction at Kawa-saki dockyards works.

Elaborate plans have been made to electrify the Tōkaidō and Sanyō lines from Tōkyō to Shimonoseki, as well as many other lines, especially those with heavy grades and tunnels; little work, however, has gone forward on these projects.

F. Locomotive and rolling stock equipment.

No statistics regarding motive power and rolling stock equipment on Japanese railroads after 1937 are available. In that year, the Government Railways owned 4,235 locomotives, of which about 200 were electric. The latest complete data on motive power and rolling stock published in the English edition of the Government Railway reports are in the annual report for 1935. In 1935, the total number of locomotives of all types on the Government Railways was 3,986, of which 165 were electric and 3,811 steam.

Data on cars are given in TABLE VII - 3.

TABLE VII - 3.
ROLLING STOCK ON GOVERNMENT RAILWAYS, 1935.

		Seating Capacity		Capacity Metric Tons	
	Number	Total	Average	Total	Average
Passenger cars of all types, including baggage, sleeping, and dining cars	10,813	689,201			
Regular passenger cars	8,946	632,449	72		
Electric passenger cars	1,347	141,953	105		
Freight cars	66,696			892,462	13.4
Covered	36,182			456,466	12.7
Open	30,294			433,400	14.3
Tank	220			2,596	11.8

It has been estimated that, in 1942, there were some 5,000 locomotives, 15,000 passenger cars, and 85,000 freight cars in service on the Government Railways, and about 3,500 units of rolling stock of all types on local railways. From these figures and the regional distribution given in the 1935 annual report, it is possible to estimate roughly that there are about 2,300 locomotives operating in the area of Southwest Japan at the present time.

(1) *Types of locomotives.*

The principal classes of passenger engines are 4-6-2 types with double bogie tender and a total weight of 115 tons (FIGURES VII - 22 and VII - 23). Freight engines are generally 2-8-2 types, with double bogie tender and a total weight of 124 tons. There are probably many older types of locomotives still in service. These include Class 8620 passenger engines, with 4-6-0 wheel arrangement, and the C51 class, an early 4-6-2 type first introduced in 1919. This engine with tender weighs 110.5 tons. It has driving wheels 5 feet, 9 inches in diameter.

The C50 class, used in local passenger service since 1929, is a 4-6-0 type. The engine alone weighs 52.8 tons, and the total weight with fully loaded 6-wheel tender is a little less than 88 tons. The tractive effort is about 20,800 pounds.

Class C53, used for express service on main lines, is a 3-

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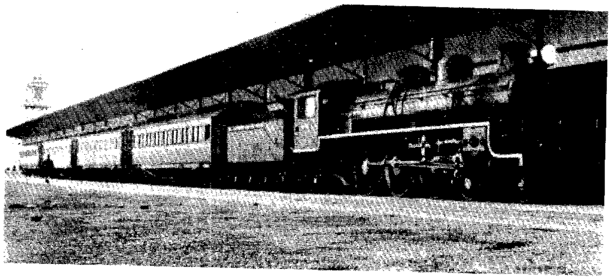

FIGURE VII - 23. *Kōbe.*
Special train on the dock with 4-6-2 passenger locomotive.

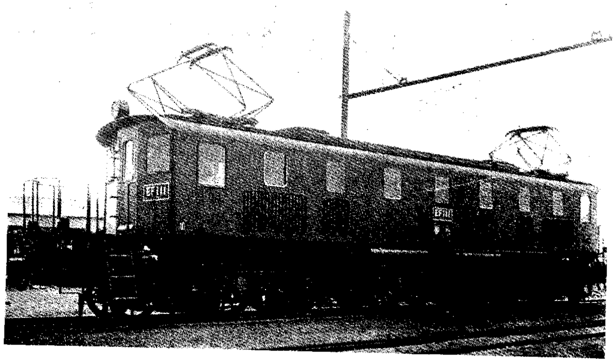

FIGURE VII - 24.
Electric locomotive of the Imperial Government Railways. Type used on heavy grades. 1934.

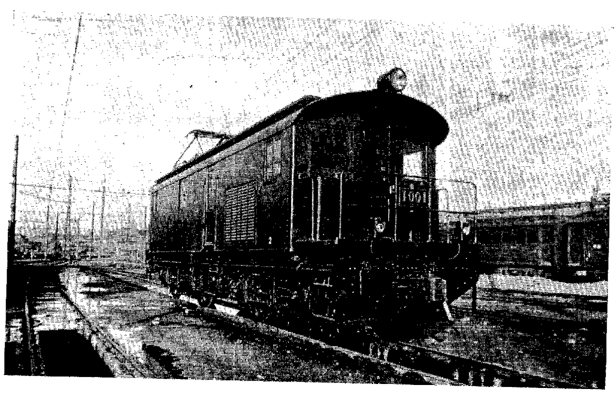

FIGURE VII - 25.
Electric locomotive used on Tōkaidō line of Imperial Government Railways. Type 1000. 1928.

cylinder, 4-6-2 type. It has an 8-wheel tender, and the total weight of engine and tender is 130 tons. The driving wheels are 5 feet, 9 inches in diameter; adhesion weight is 46.2 tons, and weight on the driving wheels is "well over" 15 tons per axle.

Until 1923, the standard freight engine was a 2-8-0 type. The present 2-8-2 type, class D50, and its streamlined variant, D51, have driving wheels 4 feet, 7 inches in diameter, and weigh, complete with 8-wheel tender, 138 tons. Steam pressure was originally 185 pounds per square inch, but is now 200.

The tractive effort of Japanese locomotives averages about 40% less than that of American engines.

Several types of electric locomotives are illustrated in FIGURES VII - 24 to VII - 28. Older types, built more than 15 years

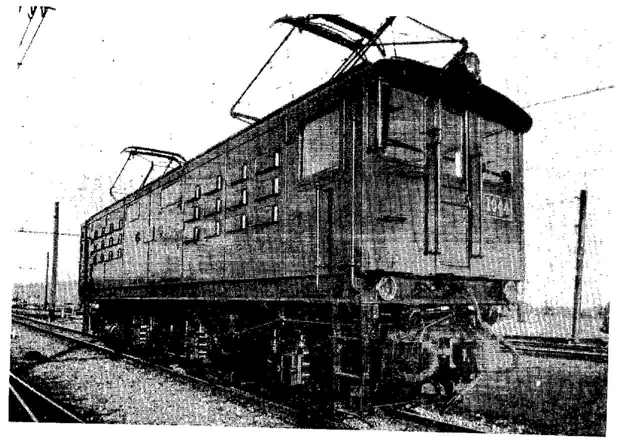

FIGURE VII - 26.
Electric locomotive used on Imperial Government Railways. 1928.

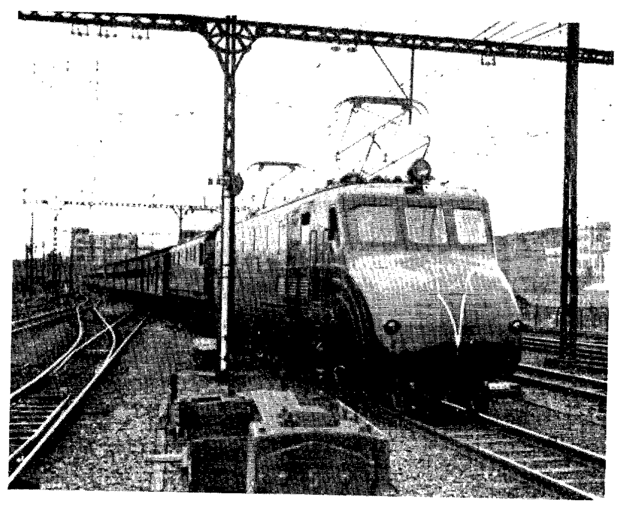

FIGURE VII - 27. *Tōkyō.*
Streamlined electric locomotive of the Imperial Government Railways. Before 1937.

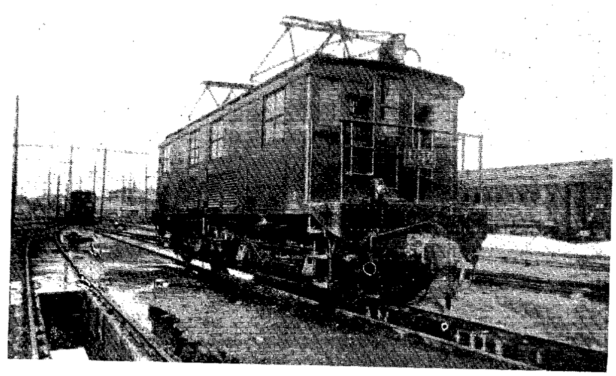

FIGURE VII - 28.
Electric locomotive, type 1010, of the Imperial Government Railways. 1928.

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ago, had a maximum speed of 40 miles an hour in freight service, and 53 miles an hour in passenger service. Newer ones, weighing 80 tons, will pull a trailing load of 470 tons up a 1% grade at 60 kilometers (37 miles) an hour. Others weigh 106 tons and have a tractive effort of 9.2 metric tons. Many have 4 motors geared directly to the driving axles, which carry the entire weight of the locomotive.

(2) *Cars.*

The old 4-wheel passenger cars had practically disappeared by 1935 and had been replaced by cars with 4- or 6-wheel trucks; the former are far more numerous. The standard length for all passenger cars today is 20 meters (65.6 feet), and the standard width is 2.9 meters (9.5 feet). Many older cars, 17 meters (55.8 feet) long, are probably still in service. Trucks of American type, with equalizers, were standard for many years, but about 20 years ago a new design, without heavy equalizers, was adopted.

Various types of electric passenger cars are shown in FIGURES VII - 29 to VII - 31.

Freight cars are still mostly of 4-wheel type, with capacities ranging from about 10 to 15 tons. The latter figure is the present standard. For gondola cars, the standard capacity is 17 tons, but a number of 30-ton box cars, gondolas, and other special cars (FIGURE VII - 32) with 4-wheel bogie trucks, are in service. All-steel cars are standard equipment, but old wooden ones are still numerous.

Recently, the Japanese government has attempted to increase the carrying capacity of the railroad rolling stock by the use of a 3-axle truck (FIGURE VII - 33). Such trucks will carry a 30-ton load, and, although they cause difficulties on curves and switches and are less efficient and durable than bogie trucks, they are much cheaper and lighter; they are now being used in large numbers to carry coal, ores and timber.

When troops are transported in freight cars, the average 15-ton box car is considered to have a capacity of 40 soldiers.

All rolling stock, both passenger and freight, is fitted with Westinghouse air brakes and automatic buck-eye couplers. Passenger cars are electrically lighted.

G. Repair facilities and yards.

The Japanese have been highly successful in adapting American railroad shop practices to their own needs, and in devising

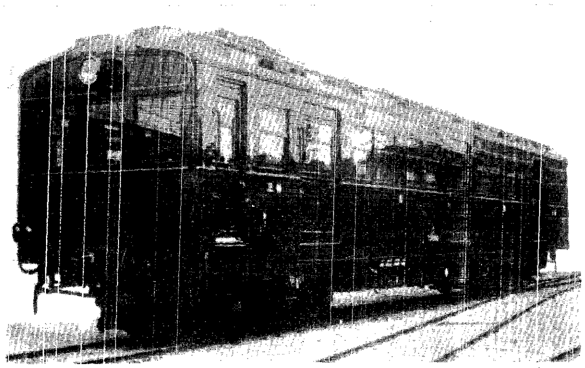

FIGURE VII - 29. *Tôkyô.*
Type of third-class passenger car used in suburban service or the Imperial Government Railways.

FIGURE VII - 30. *Ōsaka.*
Type of electric motor car used on Hanshin Electric Railways between Ōsaka and Kōbe.

improvements and new methods. As a result, it is claimed that, during a 15-year period, the time required for general repairs to locomotives was reduced from an average of 41.6 days to 6 days. At the same time, the average time for general repairs to passenger cars was reduced from 19.2 days to 7.1 days, and for freight cars from 7 days to 16.4 hours.

(1) ***Repair shops.***

The organization of the various repair shops of the Government Railways is practically the same everywhere. A works manager is in charge, with officers corresponding to general foremen supervising each division, such as shops, power plants, storehouses, and inspection. The works manager is assisted by a so-called secretariat, which handles the local research work and other technical matters, in addition to accounting and general office work.

The speed with which repairs are made in Japanese shops is greatly facilitated by the fact that spare parts for replacement are kept in every shop. When a locomotive is reassembled, these parts are used as far as possible to replace defective ones, which are set aside to be repaired later and used on other locomotives.

On 31 March 1937, a total of 15,500 men were employed by the shops of the Imperial Government Railways. The location of the shops in Southwest Japan is shown in FIGURE VII - 58, and is given below; the most important ones are starred.

Kyūshū: Kokura*, Wakamatsu*, Nishi-Kagoshima*, Nōgata, Yukuhashi.
Honshū: Shimonoseki, Hatabu*, Takatori* (Kōbe), Suita* (Ōsaka), Nagoya, Hamamatsu*.
Shikoku: Tadotsu, Tokushima.

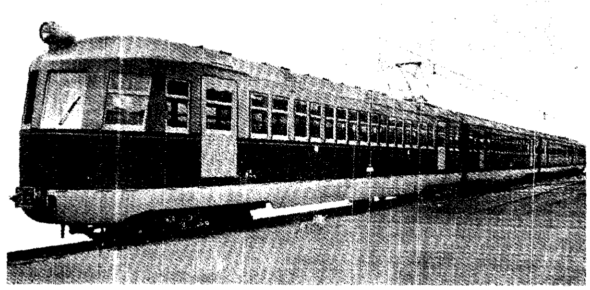

FIGURE VII - 31.
Streamlined electric train used between Ōsaka and Kōbe, 1936.

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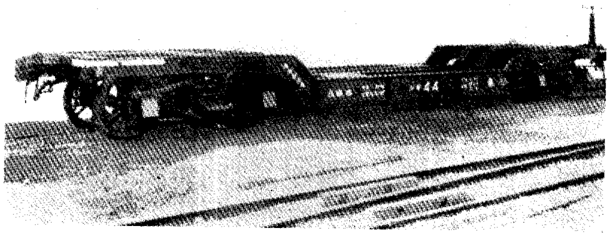

FIGURE VII - 32. *Tōkyō.*
Special depressed-center car with 4-wheel trucks.
Imperial Government Railways. 1929.

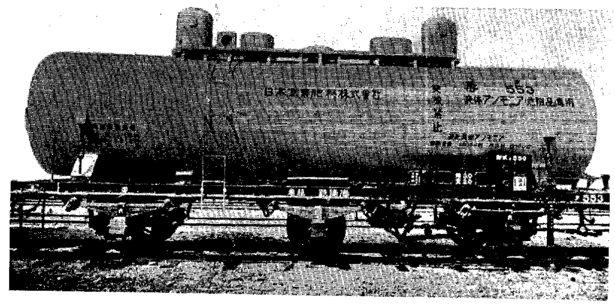

FIGURE VII - 33. *Minamata.*
Special 6-wheel tank car used for transportation of ammonia. 1937.

In addition to the above, car repair shops are located at Miyakonojō (Kyūshū) and Hamada. A research laboratory is maintained at Shimbashi (Tōkyō).

(2) ***Roundhouses and engine sheds.***

In 1936, the number of engine houses of all kinds was about 170. They are located at comparatively short distances from each other. Passenger trains are usually run over 2 sections, skipping one intermediate depot, but freight engines are run over 1 section. The average locomotive running distance in 1936 was 176 miles for passenger service, and 84 miles for freight trains. These distances have probably been increased.

A list of known roundhouses and engine sheds is given below: They are located on FIGURE VII - 58. The list is not complete.

Kyūshū: Moji, Wakamatsu, Tosu, Hizen-Yamaguchi, Sasebo, Haiki, Nishi-Kagoshima, Hitoyoshi, Takamori, Bungo-mori station, Ōita.

Honshū: Shimonoseki, Marifu, Hiroshima, Fukuyama, Okayama, Tamano, Akashi, Takatori, Ōsaka, Wakayama, Tanabe, Gojō, Suita, Inazawa, Kameyama, Matsuzaka, Nagashima, Nagoya, Hamamatsu, Ōta, Tsuruga, Sanda, Shin-Maizuru, Toyooka, Agei, Hamada, Iwami-Masuda (near Takatsu on Sanin line), Shōmyōichi (near Senzaki).

Shikoku: Tadotsu, Tokushima, Ōtsu, Uwajima.

(3) ***Yards.***

Classification or marshalling yards are operated at the following places:

Kyūshū: Wakamatsu (FIGURE VII - 34), Tosu, Nōgata, Dairi (Moji).

Honshū: Hiroshima, Higashi-Nada (Kōbe), Suita (Ōsaka) (FIGURE VII - 35), Umekoji (Kyōto), Maibara, Inazawa (near Nagoya), Nagoya, Hirano (near Ōsaka, on Kansai line), Tsu.

Shikoku: Takamatsu.

Most of these yards are of the flat switching type. Those at Tosu (capacity: 3,000 cars daily), Suita (capacity: 5,000 cars daily), and Hiroshima are of the hump gravity type.

There are many other large and important freight yards not classed as marshalling yards. These are found in every large city and at most important junction points.

H. Traffic.

(1) ***Freight traffic.***

(*a*) *Volume.* The State Railways in Southwest Japan will haul about 90,000,000 metric tons (99,000,000 short tons) of freight during 1944. Although no details are available, it is apparent that the heaviest tonnage will move over lines in the Moji district; the combined tonnage of the Ōsaka district and that part of the Nagoya district which is included in the area is roughly equal to the Moji district volume, while traffic in the Hiroshima district is quite small, running about 10 to 15% of the total.

Details on average haul are not now available, but 1937 figures show a range from 61 kilometers (38 miles) in the Moji district to 208 kilometers (132 miles) in the Hiroshima district. The relatively short average haul in the Moji district reflects concentrated industrial activity as well as the importance of the coal movement, which is characterized by short hauls. Similarly, the lack of concentrated activity in the Hiroshima district accounts for the relatively long average haul noted.

Local railways in Southwest Japan will handle about 22,000,000 metric tons of freight during 1944 (about 24,000,000 short tons). This estimate refers to lines which were "local" prior to the war and does not allow for the fact that an indeterminate number have become part of the state railway system. The average haul on local lines in 1937 was 22.4 kilometers (about 15 miles).

In addition to the State and local railways, tramways will carry about 1,000,000 tons, primarily within metropolitan areas.

(*b*) *Commodities.* The relative importance of principal commodities in the freight traffic of the Imperial Government Railways is shown in TABLE VII - 4. The figures, based on 1938 traffic, apply to the entire state railway system, but similar conditions are believed to exist on the lines of Southwest Japan. Coal, by far the most important commodity handled before the war, is probably even more dominant today as a result of the program to divert traffic from coastwise to rail transport. The important Chikuhō, Miike, and Karatsu coal fields of northern Kyūshū, and the Ube field on the southern tip of Honshū are the chief sources of fuel for the industries of Southwest Japan. The current proportion of coal on the railroads in the area is therefore probably closer to 50% of the total traffic.

(*c*) *Seasonal pattern.* Formulated on the basis of monthly tonnage figures, TABLE VII - 5 shows seasonal fluctuations in traffic. During 1940-1942, the peak periods were from March to May and from October to December, while low points were experienced during the early and middle months of the year. It will be noted that the amount of variation is relatively small. Recent information indicates that there has been some smoothing of the seasonal fluctuation, leaving a trough only during the summer months—especially July and August.

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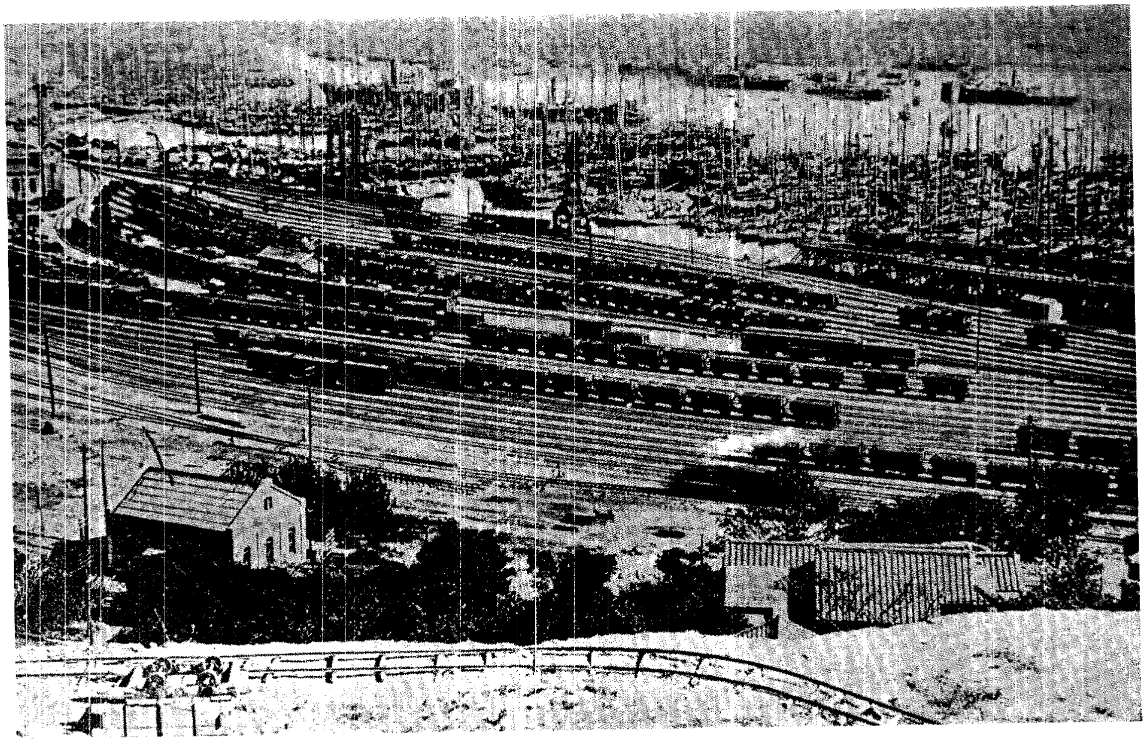

FIGURE VII - 34. *Wakamatsu.*
Part of railroad yards and harbor at Wakamatsu. Harbor has depth of 25 feet, artificially maintained. 1939.

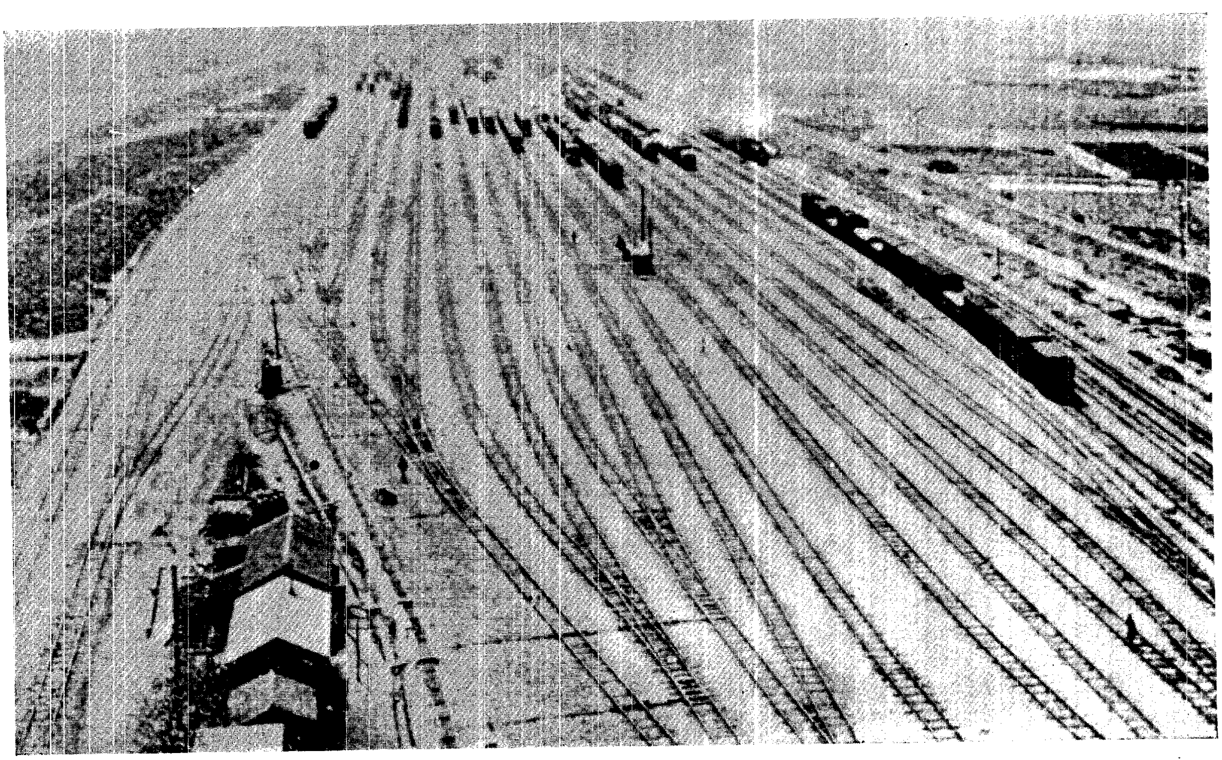

FIGURE VII - 35. *Suita.*
Classification yards. Yards of hump gravity type, with capacity of 5,000 cars daily.

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(2) ***Passenger traffic.***

(*a*) *Number of passengers.* It is estimated that the Imperial Government Railways of Southwest Japan will carry about 520,000,000 passengers during 1944. Local railways will handle about 525,000,000, while tramways will carry about 1,960,000,000.

On the State Railways, trains of 5 or 6 cars carry passengers an average of about 50 kilometers (about 31 miles), varying from 22 kilometers (about 14 miles) in the congested Ōsaka district to over 40 kilometers (about 25 miles) in the Nagoya district. On local railways, the average trip is about 9 kilometers (about 6 miles). It can be seen, therefore, that passenger traffic in the area is essentially a commuter service.

(*b*) *Restrictions on passenger traffic.* The total number of passengers carried, especially on State Railways, would be substantially greater than is indicated above except for numerous wartime restrictions. During 1943, second-class cars were to be entirely removed from 33 lines, while partial changes were to be made in the service on 7 other lines. Second-class travel for daily and shortline limited service was to be discontinued on 4 lines. It was proposed that passenger cars eliminated under this ruling be rebuilt for use in freight service.

After 1 April 1944, all special limited, first-class, sleeper, and diner service was to be abolished. Second-class service was to be abolished on 22 lines and further restricted on others. No baggage was to be checked through on tickets. Trips of over 100 kilometers (about 62 miles) were to be restricted by ticket rationing.

It is believed that these restrictions have reduced passenger travel by about ⅓ from the peak levels of early 1943.

I. Capacity.

(1) ***General limitations.***

Fundamentally, Japanese railroad capacity is limited by the 3′6″ gauge. Narrow-gauge construction requires that freight cars be built relatively wide in order to achieve any appreciable carrying capacity. This results in an overhang which cuts down train speeds as much as 30%. Furthermore, the fact that speeds are automatically limited by overhang makes curve reduction less necessary. In other words, major improvements designed to increase train speeds are not economical, as freight car characteristics prevent full utilization of such improvements. Sharp curves and heavy grades are attendant weaknesses. It has been stated that about ⅓ of the rail lines in Japan have limiting grades of more than 1%, a fact which limits the size and weight of trains.

(2) ***Operating characteristics.***

The average freight train in Japan today probably weighs about 700 metric tons (770 short tons). It consists of a locomotive and tender weighing 130 metric tons (144 short tons), plus 35 cars weighing 280 metric tons (310 short tons), and carrying about 300 metric tons of freight (330 short tons). There is relatively little variation among districts; in 1937, the average train in the Moji district had 31.3 cars as compared with 35.8 cars in the Nagoya district. It is probable that the comparatively small number of cars in the Moji district is the result of the high proportion of heavily loaded coal cars.

The most important lines are now believed to have automatic signalling and interlocking equipment. This is especially significant, as many principal lines are single-track; without this equipment, capacity would be considerably lower. No specific evidence indicates the use of centralized traffic control systems as a means of increasing capacity.

Because of the narrow-gauge construction, locomotives are relatively small. The maximum speed of freight locomotives is about 70 kilometers (43 miles) per hour, with tractive effort averaging about 32,000 pounds. It is believed that steam locomotives are used about 16 or 17 hours per day, with resulting heavy maintenance requirements. One source has estimated that as many as 40% of the locomotives in some sections are awaiting or undergoing repairs; the actual average is probably much smaller, but it is reasonably certain that locomotives in Japan are being used at capacity.

Available evidence indicates that the principal double-track lines can handle up to 60 or even 100 trains per day in each direction, while capacities on principal single-track lines may run from 25 to 45 trains per day. Less important single-track lines can handle far fewer trains per day. In view of the operating difficulties encountered, it is considered unlikely that these rates can be surpassed, unless centralized traffic control systems have been installed.

(3) ***Measures to increase capacity.***

A major step to increase capacity has been the drastic reduction in passenger service. In May 1943, it was announced

TABLE VII - 4.
JAPANESE RAILROAD TRAFFIC,
SELECTED COMMODITIES AS PERCENTAGE OF TOTAL,
1938

COMMODITY	PERCENTAGE
Coal	39.2
Timber	9.9
Ores	4.6
Fertilizer	4.0
Rice	3.2
Iron and iron ore	1.8
Cement	1.4
Charcoal	1.3
Wheat, barley, etc.	1.2
Cotton yarn and fabric	.5
Other	32.9
Total, All Commodities	100.0

TABLE VII - 5.
SEASONAL PATTERN OF JAPANESE RAILROAD TRAFFIC
(Monthly percentages of annual totals)
Average, 1940-1942

MONTH	PERCENTAGE OF TOTAL
January	7.4
February	7.5
March	8.8
April	8.4
May	8.8
June	8.1
July	8.2
August	8.2
September	8.2
October	8.7
November	8.7
December	9.0
Year	100.0

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that passenger cars would not be allowed to use single-track lines, in order to increase freight movements. The minimum load per car was raised to 6 and 9 tons, compared with a 5-ton minimum since December 1941. Loading and unloading were to take place on holidays and at night. As early as September, 1942, it was announced that non-essential goods traffic would be reduced to permit increased movement of coal, iron, light metal, aircraft, shipbuilding and other armament material, and foodstuffs. The Government proposed to fill in the seasonal summer decline by moving increased amounts of war materials during July and August.

(4) *Conclusions on capacity.*

It is believed that the Japanese railroads are operating close to capacity, primarily because of rail line limitations and a tight car supply.

The importance of line limitations—that is, the inability to move more than a specified number of trains per day over particular lines—is indicated by the reduction in passenger service. Moreover, a radio broadcast in July 1943, stated that "transportation of important materials such as coal, iron, and steel is being handled as much as possible by overland facilities." This suggested that rail line capacity and car supply in the areas involved may be the limiting factors. On the other hand, further cuts may be made in passenger traffic without serious loss to the war production program, although it is likely that major cuts would curtail essential travel in industrial areas.

Strenuous efforts to increase freight car production would indicate that cars are a limiting factor in railroad capacity. This is substantiated by plans to rebuild passenger cars for freight service. On the other hand, it should be observed that part of the demand for car production arises from the intensified use of existing equipment, with resulting increases in maintenance requirements; moreover, an unknown but substantial part of the new production is undoubtedly destined for use in other parts of the Japanese Empire.

The comparative lack of pressure for locomotive output suggests that motive power is not a bottleneck. This may mean that the lines are handling as many trains as possible, or that there is excess locomotive capacity. The latter explanation is improbable. It therefore appears sound to infer that the car production program may be designed to permit the running of longer—and slower—freight trains.

Insufficient information is available to permit the assessment of the importance of classification yards and terminals as a limit on overall capacity.

To summarize: Although no precise conclusions can be reached, it seems clear that Japanese railroads cannot handle significant increases in traffic without major improvements in line capacity and car supply.

J. Vulnerable points.

Japanese railroads as a whole are highly vulnerable, as a result of 3 primary factors: 1, the small size of the islands; 2, the extraordinary abundance of bridges, tunnels, and landslide areas; and 3, the proximity of main lines to coasts. A fourth factor might well be added—the frequency of minor earthquakes, which produce latent weaknesses in many kinds of structures.

In the mountainous interior or along rugged coasts, where tunnels are especially numerous, bridges and landslide areas are also likely to be unusually abundant. Hence such regions are particularly vulnerable to attack. On the other hand, the most vulnerable bridges are likely to be found along low coasts, where streams spread out in broad channels, making long bridges necessary.

Many bridges of this type have been indicated on FIGURE VII - 58, which also gives the locations of selected tunnels and tunnel zones.

In addition to these types of vulnerable areas or structures, there are other vulnerable places that result from the congestion of traffic or the location of specially important facilities. A number of such places have also been indicated on FIGURE VII - 58. Among them, the following are of primary significance:

1. Orio, on the Kagoshima line, 19 miles west of Moji. Three double-track lines meet here, one of which carries large quantities of coal from the Chikuho fields. This coal not only moves to many industrial centers in Honshū and northern Kyūshū, but also supplies a large proportion of the fuel consumed on the Government Railways.

2. Okayama. A junction point of 4 lines, including the important line to Tamano, which connects by train ferry with the railroads of Shikoku.

3. Kyōto-Ōtsu region. Two long tunnels and an important classification yard are located within the space of a few miles.

4. Maibara. A bottleneck for converging traffic on the Tōkaidō line and the important cross-island route from Tsuruga. There is also a classification yard here.

5. Tsuruga. A port for shipments from Korea and Manchuria and junction point of several lines.

6. Nagoya. Very important rail center. Meeting point of Tōkaidō, Chuo, and Kansai lines, as well as others. Bridges, shops and classification yards.

K. Description of individual lines.

(NOTE: In the last 10 years, relatively little has been published in English on the railroads of Japan. The English edition of the Government Railway report was discontinued after 1937. The most recent major source of information on private railroads in English is dated 1936, but there is no comparable source on the government-owned railroads, which include practically all the important lines in Japan. Information from Japanese sources, received after the preparation of this study, will be published as a supplement, and will contain more data on individual lines, including secondary and private lines.)

Individual lines described below are followed by a capital letter in parentheses (Line A, etc.) which refers to their designation on FIGURE VII - 58.

(1) *Kagoshima line (Kyūshū) (Line A).*

From Moji to Hakata (Fukuoka), the line runs close to the coast. It then turns sharply south and crosses a plateau country to the west coast at Ōmuta, on Shimbara-kaiwan (bay). From Ōmuta almost to Yatsushiro, it traverses gently rolling country, usually a few miles inland. North of Yatsushiro, mountain spurs force the line close to the coast for 90 miles. Here the track is often almost at the water's edge, and in places runs on a narrow shelf cut out of the mountainside, with numerous

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tunnels. At Ijūin the railroad crosses a level plain at the neck of the peninsula bounding Kagoshima-wan (bay) on the west.

(*a*) *Termini.* Moji and Kagoshima.

(*b*) *Length.* 400 kilometers (248 miles).

(*c*) *Gauge and track.* 3′6″; double-track from Moji to Tosu (possibly to Kurume), single track from Tosu to Kagoshima.

(*d*) *Power.* Steam.

(*e*) *Yards.* Dairi (3 miles west of Moji); Hakata, east of Fukuoka. Kurume has sidings but little marshalling. Northeast of Tosu are hump gravity yards, which are the most important on Kyūshū, and have a capacity of 3,000 cars a day. The Kagoshima yards handle much ship-borne traffic.

(*f*) *Shops.* Kokura has the most important railroad shops in Kyūshū. These shops build and repair cars and locomotives. Ōmuta has shops for the mine railroad. Tosu and Kagoshima also have shops.

(*g*) *Roundhouses and enginehouses.* Moji, Dairi, Hakata, and Tosu.

(*h*) *Vulnerable points.* Kokura is the junction of the Kagoshima and Nippō Lines and of an alternate route running between these 2 lines. The junction at Orio is stated to be a bottleneck in the transportation of coal from the Chikuhō-tanden (coal fields). At Yatsushiro, the Kuma-gawa (river) bridge, a tunnel, and a railroad junction are within a short distance of each other. At Kagoshima, the repair shops, freight yards, the bridge over Kotsuki-kawa (river), and a tunnel are within a mile of each other.

(*i*) *Bridges.* There are 17 bridges between Kurosaki and Yatsushiro. The bridge over Tatara-gawa (river) northeast of Fukuoka is about 1,000 feet long. The new railroad bridge over Chikugo-gawa (river) at Kurume is a lift span bridge, 337 meters long. A Warren truss type bridge with a center span 46 meters long crosses Rokukaku-gawa (120 kilometers from Moji). A long bridge crosses Kuma-gawa at Yatsushiro.

(*j*) *Tunnels.* There are 20 major tunnels on this line, all of them between Hinago and Kagoshima. Three of the tunnels are over 1,000 meters long: the Shashikitaru Tunnel, 1,463 meters; the Tsunakitaro Tunnel, 1,311 meters; and the Akematsutaro Tunnel, 1,007 meters (exact locations unknown).

(*k*) *Branch lines.*

1. THE KOKURA ELECTRIC (passenger) line runs between Moji and Orio. It has a 4′8½″ gauge, with 60- and 108-lb. rails. It has its own power plant at Kokura and 8 substations. Rolling stock consists of 125 motorcars.

2. AT KOKURA, the Nippō line branches from the Kagoshima line and goes down the east coast of Kyūshū.

3. A DOUBLE-TRACK BRANCH line runs from Orio northeast to Wakamatsu. Wakamatsu has a roundhouse, marshalling yards of the flat switching type, and important repair shops. From Orio, another double-track branch goes southeast to Ita, from where it continues as a single-track line eastward to Yukuhashi on the Nippō line. At Nōgata, on the double-track line, there are yards of the flat switching type. From Nōgata a double-track branch goes southwest to Kotake and continues as a single-track line to join the Kagoshima line south of Futsukaichi. There is a tunnel on this branch.

4. FROM FUKUOKA, a double-track electric line runs 24 miles south to Kurume. This line has a 4′8½″ gauge, and 75-lb. rails. There is a long bridge over Chikugo-gawa at Kurume. Rolling stock consists of 36 passenger motorcars, 18 freight motorcars, and 8 other motorcars.

5. AT TOSU, the Nagasaki line (B) branches off.

6. AT KURUME, the single-track Daito line (F) goes east to Ōita.

7. AT KUMAMOTO, the single-track Hōhi Line (E) runs east to Ōita.

8. THE HISATSU LINE (C) branches off at Yatsushiro.

9. AT KAGOSHIMA, the line continues northeastward to Hayata, where it joins the Hisatsu line and the extension of the Nippō line from Miyakonojō.

(2) *Nagasaki line (Kyūshū) (Line B).*

(*a*) *Termini.* Tosu and Nagasaki.

(*b*) *Length.* 123 kilometers (76 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Tosu, Isahaya.

(*f*) *Shops.* Tosu.

(*g*) *Enginehouses.* Hizen-Yamaguchi.

(*h*) *Vulnerable points.* This line has sharp turns, which prevent expresses from going faster than 30 m.p.h. It also has sheer cuts, and steep embankments.

(*i*) *Bridges.* There are important bridges over Nagayo-gawa, Shimono, and Rokkaku-gawa. Between Kubota and Saga there are 12 bridges.

(*j*) *Tunnels* There are 5 tunnels between Isahara and Nagasaki.

(*k*) *Branch lines.*

1. THE BRANCH going southeast from Saga joins the Kagoshima line at Sedake. It crosses a 506-meter long lift span plate girder and truss bridge over Chikugo-gawa.

2. A SINGLE-TRACK LINE runs from Isahaya northwest to Sasebo, Hayaki, on this line, has an enginehouse.

(3) *Hisatsu line (Kyūshū) (Line C).*

This line runs through the gorge of Kuma-gawa between Yatsushiro and Hitoyoshi. It crosses the river several times, and has many grades, tunnels, and sharp curves. There are also heavy grades and numerous tunnels between Hitoyoshi and Yoshimatsu. There is a spiral loop 4 miles south of Hitoyoshi.

(*a*) *Termini.* Yatsushiro and Hayato.

(*b*) *Length.* 152 kilometers (94 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Roundhouses.* Hitoyoshi.

(*f*) *Vulnerable points.* There is a spiral loop between Hitoyoshi and Yoshimatsu which is, in part, within a tunnel.

(*g*) *Bridges.* This line has 7 major bridges. The following are over 100 meters long:

NAME	KM. FROM YATSUSHIRO	DESCRIPTION
Kuma-gawa No. 1	19	205 m. long; 2 spans, each 61 m. Trusses; masonry abutments and piers; concrete foundation.

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Kuma-gawa No. 2	46	180 m. long; 2 spans, each 61 m.; 2 spans, each 24 m. Plate girder, masonry abutments and piers; concrete foundation.
Yamada-gawa	55	121 m. long; 9 spans, each 12 m. Trusses; stone abutments and piers; concrete foundation.
Kuma-gawa No. 3	56	195 m. long; 2 spans, each 61 m.; 5 spans, each 21 m. Trusses; masonry abutments and piers; concrete pile foundation.

(*b*) *Tunnels.* There are 22 major tunnels on this line. The longest is Yataka Tunnel No. 1, 13 kilometers north of Yoshimatsu, which is 2,096 meters long and has a grade of 0.125%. Tunnels which are over 100 meters long are:

NAME	KM. FROM YATSUSHIRO	LENGTH IN METERS
Yayeyoyama No. 2	39	210
Minase No. 1	62	201
Minase No. 2	62	236
Tachiishi	63	141
Yokohira	63	503
Ono No. 1	68	322
Ono No. 2	69	310
Ono No. 4	70	286
Yatake No. 1	74	2,096
Yatake No. 2	76	148
Yatake No. 3	76	131
Yazuru	77	493
Natake	78	210
Hekobira	79	202
Yamagami No. 1	80	173
Yamagami No. 2	81	618
Matsuo	82	121
Maruzaka	83	141
Nagaseko	83	262

(4) ***Nippō line (Kyūshū) (Line D).***

(*a*) *Termini.* Moji and Yoshimatsu.

(*b*) *Length.* 463 kilometers (288 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Moji and Ōita have large railroad yards.

(*f*) *Shops.* Kokura has the largest repair shops on Kyūshū. There are shops at Yukuhashi and Miyakonojō; Nakatsu may have shops.

(*g*) *Enginehouse.* Ōita.

(*h*) *Vulnerable points.* Between Kitsuki and Ōita there is a narrow coastal plain, and railroad, highway, and electric transmission lines are close together. Ōita is the junction of lines from 4 points.

(*i*) *Bridges.* There are 20 major bridges on this line. The following are over 100 meters long:

NAME OR RIVER	KM. FROM MOJI	DESCRIPTION
Ekitate-gawa	81	293 m. long; 9 spans, each 21 m., 4 spans, each 18 m., 1 span of 6 m. Plate girder, masonry abutments; pile concrete foundation.
Yasaka-gawa No. 1	103	116 m. long; 7 spans, each 15 m. Plate girder, stone abutments, concrete foundation.
Yasaka-gawa No. 4	109	104 m. long; 2 spans, each 21 m., 3 spans each 18 m. long. Plate girder; stone abutments; concrete foundation.
Yasaka-gawa No. 5	109	104 m. long; 4 spans, each 21 m., 1 span of 12 m. Plate girder, stone abutment, concrete foundation.
Yasaka-gawa No. 6	111	141 m. long; 5 spans, each 21 m., 2 spans each 12 m. Plate girder, stone abutment, concrete foundation.
Ōita-gawa	146	About 152 m. long.
Ototsu-gawa	151	149 m. long; 7 spans, each 21 m. Steel girder on concrete abutments.
Ono-gawa	153	279 m. long; 13 spans, each 21 m. Steel girder, concrete abutments.
Miyazaki	351	About 300 m. long; 17 short stone or concrete arches.

(*j*) *Tunnels.* This line has 44 major tunnels. Between Ōita and Saeki there are 28 tunnels, and between Ōyodo and Miyakonojō there are 7 tunnels, each over 169 meters long. The following tunnels are over 100 meters long:

NAME OR MOUNTAIN	KM. FROM MOJI	LENGTH IN METERS
Tateishi-gawa	94	312
Ohara-yama	103	131
Nino	105	146
Jindengao	107	429
Akamatsu	107	151
Furuichi	126	191
Hotokezaki	138	231
Sashi	...	1,433
Aoidake	380	1,529

(*k*) *Branch lines.*

1. AT KOKURA, the Nippō line branches off from the double-track Kagoshima line. From Kokura a steam railroad runs 24 miles southwest to Kami-Soeda on a 3′6″ gauge track with 60-pound rails.

2. AT YUKUHASHI, a single-track line goes west to join the Kagoshima line at Futsukauchi, and northwest to Orio.

3. FROM ŌITA the single-track Daito line (F) goes west to Kurume, and the single-track Hōhi line (E) goes west to Kumamoto.

4. FROM MIYAKONOJŌ a branch continues westward to Hayata and Kagoshima.

(5) ***Hōbi line (Kyūshū) (Line E).***

(*a*) *Termini.* Kumamoto and Ōita.

(*b*) *Length.* 148 kilometers (92 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Enginehouses.* Ōita.

(*f*) *Bridges.* The Shira-gawa No. 1 bridge (near Aso volcano) is a 152-meter balanced arch steel deck bridge with 3 spans. It is 59 meters above the water, which is said to make it the highest railroad bridge in Japan. There are 7 other bridges on this line.

(6) ***Daito line (Kyūshū) (Line F).***

This line traverses rugged country, following the valleys of several streams most of the way. About 15 miles west of Ōita it crosses a divide by means of a sharp loop and several tunnels.

(*a*) *Termini.* Ōita and Kurume.

(*b*) *Length.* 142 kilometers (88 miles).

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(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Kurume has sidings but little marshalling. Ōita has large yards.

(*f*) *Roundhouses and enginehouses.* Ōita, Bungo-mori station.

(*g*) *Tunnels.* There are a number of tunnels on this line, including the Mizuwake, 6,000 feet long, 17 miles west of Ōita. Just east of this point are 2 shorter tunnels and a sharp loop.

(7) ***Sanyō line (Line G).***

The Sanyō line runs near the shore of Ōsaka-wan (bay) for 50 miles west of Kōbe. At Une, the line turns inland, and for 234 miles crosses a series of mountain spurs and small plains. In places it emerges on the coast and clings to the bases of steep-sided head-lands. The remaining 69 miles east of Shimonoseki is a rolling country with small basins.

(*a*) *Termini.* Kōbe and Shimonoseki.

(*b*) *Length.* 508 kilometers (316 miles).

(*c*) *Gauge and track.* 3′6″; double-track except from Marifu to Kushigahama, which is single-track.

(*d*) *Power.* Electricity from Kōbe to Akashi; steam from Akashi to Shimonoseki.

(*e*) *Yards.* The Kōbe station yards handle residential and commercial freight. The yards at Hyōgo (Kōbe) are said to be even more important, as they handle freight from the industrial section. Takatori (west of Hyōgo) and Okayama also have yards. Hiroshima has large classification yards of the hump gravity type. There are yards at Hatabu and Shimonoseki.

(*f*) *Shops.* Takatori (Kōbe) has one of the 5 most important repair and maintenance shops in Japan. There are important shops at Hatabu, and minor ones at Shimonoseki. The Kawasaki Locomotive and Car Company in Kōbe also produces military equipment. The Hitachi Manufacturing Company at Kudamatsu is one of the principal locomotive works in Japan.

(*g*) *Roundhouses and enginehouses.* Takatori, Akashi, Okayama, Fukuyama, Hiroshima, Marifu, Shimonoseki.

(*h*) *Vulnerable points.* Between Suma and Akashi there is a narrow defile with steep, soft sandstone walls where landslides often take place. Beyond Hongō there are several miles of mountainous country with many bridges and tunnels. Beyond Iwakuni the line passes through many tunnels and crosses many small bridges for about 20 miles. There are many cuts here, and the line is continually harassed by landslides in the summer rainy season. Some of the cuts have been terraced, but most have been sprayed with liquid cement to form a thin, water-proof crust. Six miles west of Hiroshima the line is subject to avalanches. East of Kushigahama, the line has been cut out of the sides of cliffs. At Hatabu is the important junction of the Sanyō and Sanin Lines.

(*i*) *Bridges.* This line is elevated from Sannomiya station to Takatori station in Kōbe. There are 7 major bridges on this line.

(*j*) *Tunnels.* There are 8 major tunnels on this line: near Kōchi, east of Hiroshima, 1,953 meters long, with a 1% grade; 4 tunnels in and near Kuba, between Marifu and Iwakuni. The Fukada tunnel, 5 miles west of Asa, is 1,135 meters long. There are also many short tunnels. This line is connected with the railroads of Kyūshū by the Kammon tunnel.

(*k*) *Branch lines.*

1. AT HIMEJI, a branch goes north 66 kilometers to join the Sanin line at Wadayama. There is 1 bridge on this line, over the Yatabe River.

2. ANOTHER BRANCH at Himeji goes northwest to Tsuyama, where one branch goes north to join the Sanin line at Tottori, and the other goes west to connect with 2 of the transisland lines: Kurashiki to Hoki-Daisen, and Fukuyama to Shinji.

3. AT OKAYAMA, a branch runs south 33 kilometers to Tamano, where a ferry connects the line with Takamatsu on Shikoku. There is a 657-meter tunnel at Kojima (39 kilometers from Okayama). The line has 6 major bridges. The longest is 182 meters long, over Sasagase-gawa. It has 8 spans, each 21.4 meters long. It is a truss bridge with stone abutments. There is an enginehouse at Tamano.

4. AT KURASHIKI a line runs 140 kilometers north to join the Sanin line at Hoki-Daisen. It crosses the Ashimi river on a plate girder deck bridge of 16 spans, with concrete piers. There are several other bridges in Ashimi and Nariha-gawa.

5. AT FUKUYAMA, a line runs north to join the Sanin at Shinji.

6. AT MIHARA, a single-track cut-off follows the coast to Kure and rejoins the main line at Kaidaichi. Regular traffic is routed over this loop, and in 1940 it was used more than the main line. This branch goes through many tunnels. The longest tunnel is at Yano; the tunnel at Kure is 2,582 meters long. There is a long bridge over the river at Kaidaichi.

7. ANOTHER CUT-OFF, from east of Iwakuni to Tokuyama, is partly single-, partly double-track. It follows the coast, and has 1 tunnel.

8. AT OGORI, a branch runs northeast to connect with the Sanin line near Masuda. This branch has 4 tunnels.

9. AT ASA, a branch runs north to connect with the Sanin line at Fukawa. This line has 1 tunnel and many bridges.

(8) ***Sanin line (Line H).***

This line crosses the interior highlands from Kyōto to the north coast near Tōyooka, about 90 miles from Kyōto. It follows the coast for 108 miles to Yonago, often virtually at the shore line. The coast here is rugged and the railroad tunnels through cliffs and crosses numerous streams on high bridges (FIGURE VII - 18). From Yonago, the line runs slightly inland through low country, and skirts the shore of Shinji-ko (lake). About 40 miles west of Yonago, it again reaches the coast and runs along a narrow coastal plain to Hatabu, where it joins the Sanyō line.

(*a*) *Termini.* Kyōto and Shimonoseki.

(*b*) *Length.* 680 kilometers (423 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Kyōto, Shimonoseki.

(*f*) *Shops.* Hatabu, Hamada.

(*g*) *Enginehouses.* Agei, Hamada, Iwami-Masuda, Shōmyōichi.

(*h*) *Vulnerable points.* In many sections, this line passes

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through extremely rough country, and has many tunnels and bridges. In places, it is subject to frequent landslides in the rainy season. Snow sheds and slide protection have been set up east of Harnasaka.

(*i*) *Bridges*. There are 58 major bridges between Kyōto and Izumo-Imaichi.

Following are the bridges over 100 meters long:

River or Name	Distance from Kyōto (km.)	Description
Sonobe River	36	Length 149 m., 9 spans each 15.3 m. Truss bridge, masonry abutments, concrete foundation.
Oseki River No. 2	40	Length 112 m., 1 span of 61 m., 3 spans each 15.3 m. Truss bridge, masonry abutments, concrete foundation.
Oseki River No. 1	41	Length 97 m., 1 span of 61 m., 2 spans each 15.3 m. Truss bridge, masonry abutments, concrete foundation.
Itaya River	55	Length 95 m., 1 span 61 m., 2 spans each 15.3 m. Truss bridge, brick abutments, concrete foundation.
Wachi River No. 2	60	Length 133 m., 1 span 9.2 m., 3 each 18.3 m., 1 span 61 m. Plate girder, brick abutments, concrete foundation.
Wachi River No 1	60	Length 172 m., 3 spans each 18.3 m., 2 spans each 24.4 m., 1 span 61 m. Truss and plate girder bridge, brick abutment, concrete foundation.
Arakuradani River	63	Length 96 m., 2 spans each 24.4 m., 1 span 46 m. Plate girder, brick abutments, concrete foundation.
Shimonogo River	66	Length 127.4 m., 5 spans each 12.2 m., 1 span 61 m. Plate girder, masonry abutments, concrete foundation.
Maruyama	120	Length 197 m., 10 spans each 18.3. Truss bridge, abutments and piers masonry, concrete pile foundation.
Oya	130	Length 213 m., 16 spans each 12.2 m. Plate girder, masonry abutments and piers, concrete foundation.
Ogawa	139	Length 99 m., 5 spans each 18.3 m. Plate girder, masonry abutments and piers, concrete pile foundation.
Yara-kawa No. 2	178	Length 137 m., 6 spans each 21.4 m. long. Steel girder, stone abutments and piers, concrete foundation.
Yobe	185	Length 309 m., 10 spans each 17.7 m., 1 span 17.4 m., 11 spans each 8.5 m., 1 span 8.3 m. Steel girder, stone abutment and piers, concrete foundation.
Amarube	188	Very high trestle bridge supported by "Eiffel Tower" steel girder.
Rikuage	204	Length 137 m., 6 spans each 21.4 m. Steel girder, masonry abutments and piers, concrete foundation.
Iinashi-gawa	336	Length 148 m., 5 spans each 21.4 m., 1 span 18.3 m. Plate girder, stone abutments and piers, concrete foundation.
Shin-kawa	378	Length 147 m., 6 spans each 24.4 m. Steel girder, masonry abutments and piers, concrete pile well foundation.
Hii-gawa	383	Length 379 m., 11 spans each 12.2 m., 10 spans each 21.4 m. Steel girder, masonry abutments and piers, concrete foundation.

A ferro-concrete viaduct, 190 meters long, crosses the Sohgo River on this line (location unknown).

(*j*) *Tunnels*. There are 83 major tunnels on this line between Kyōto and Hamada, and about 10 additional tunnels between Hamada and Shimonoseki. The Tokan tunnel, between Kobuto and Hisatani (location not known), is 1,992 meters long. Following are tunnels over 100 meters long:

Name of Mountain	Km. from Kyōto	Length in Meters
Mt. Suo	30.4	103
Mt. Shinzen	41.5	352
Mt. Kozuke	42.6	177
Atago	54.9	101
Mt. Kojin	56.7	286
Mt. Mitsuishi	57.4	121
Mt. Hakka	57.6	339
Mt. Myojin	64.5	332
Junikoshi	124.9	449
Makiyama	125.4	205
Saruiwa	127.0	126
Jino	133.6	245
Yosemiya	135.3	131
Asakura	139.9	312
Momoshima	161.3	517
Ashidani	163.4	1838
Hamakoshi	167.5	151
Hamasui No. 1	169.6	513
Hamasui No. 2	170.3	121
Soyakoshi	170.9	402
Yakuno	171.9	1288
Kuresaka	172.7	719
Nakayama	174.3	714
Futaezaka	175.8	181
Sakotoge	176.6	1147
Kigyosan	178.0	279
Hanamitoge	179.0	915
Mushio	195.4	359
Ei	196.3	302
Shitade	197.5	1127
Akashima	198.9	173
Oiro	199.5	382
Higashi-Shitaya	200.0	117
Aketoshi	201.5	121
Momomi	203.6	1838
Hisatami	204.5	201
Ashiya	212.1	1860
Kamaya No. 2	214.8	499
Kamaya No. 1	216.0	198
Igumi	216.0	744
Mt. Shichi	230.0	559
Hosokawa	231.9	117
Enoki	236.7	531
Aoya Tunnel No. 21	253.8	151
Aoya Tunnel No. 19	255.6	437
Aoya No. 18	257.0	109
Aoya No. 17	257.5	272
Aoya No. 16	258.9	145
Aoya No. 12	264.6	976
Yado	328.2	151
Shimada	330.8	388
Yunotsu	439.3	1130
Asari No. 1	449.6	503
Asari No. 2	450 to 456	375
16 other tunnels over 92 m.	450 to 456	

(*k*) *Branch lines.*

1. In Kyōto, the Sanin line connects with the Tōkaidō main line and with a single-track line running south to the Kansai line at Kiza.

2. At Sonobe, a branch runs west to join the Kanzaki-Fukuchiyama line. At Ayabe, a branch runs east to join the Hokuriku line at Tsuruga.

3. At Fukuchiyama, a line runs south to Kanzaki.

4. At Wadayama, a branch runs south to the Sanyō line at Himeji.

5. At Toyooka, a branch runs east to Maizuru and to the Hokuriku line at Tsuruga. There is an enginehouse at Maizuru.

6. At Tottori, a line runs south to Tsuyama and Himeji.

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7. AT HOKI-DAISEN, a line runs south to the Sanyō line at Kurashiki.

8. AT SHINJI, a line runs south to the Sanyō line at Fukuyama.

9. NEAR MOSUDA, a line runs southwest to the Sanyō line at Ogōri.

10. AT FUKAWA, a branch runs south to Asa.

11. THE SANIN and Sanyō lines join at Hatabu.

(9) ***Tōkaidō line (Line J).***

Between longitude 138° and Gifu, northwest of Nagoya, most of the Tōkaidō line runs along a narrow coastal plain or across the Nagoya plain. West of Gifu, it cuts through a chain of hills to the shore of Biwa - ko (lake) at Maibara, and between Ōtsu and Kyōto, through another chain of hills, using 3 tunnels. From Kyōto to Kōbe the route follows the Yodo-gawa valley and the shore of Ōsaka-wan (bay).

(*a*) *Termini.* Tōkyō and Kōbe (Sannomiya station).

(*b*) *Length.* 590 kilometers (367 miles).

(*c*) *Gauge and track.* 3′6″; double-track; 4 tracks from Kyōto to Kōbe (possibly 6 tracks from Ōsaka to Kōbe).

(*d*) *Grade.* Maximum is 1 in 100.

(*e*) *Rails.* 100 pounds.

(*f*) *Power.* Electricity from Tōkyō to Numazu; steam from Numazu to Kyōto; electricity from Kyōto (or possibly Ōtsu) to Akashi, about 64 miles. Power is purchased from several power companies. There are 6 substations along the line. Contact system is overhead, single catenary.

(*g*) *Yards.* Hamamatsu has yards east of the station. Nagoya has extremely important yards of the flat switching type. At Inazawa (northwest of Nagoya), there are extremely important yards of the hump gravity type. There are 6 or 8 tracks and freight yards near Ōgaki station. Maibara has flat switching type yards. Umekoji yards at Kyōto are of the flat switching type; they control traffic of the Tōkaidō, Sanin, and Nara lines. Suita yards, north of Ōsaka, are hump gravity yards, and are reported to handle 5,000 cars a day. Extensive yards adjoin Ōsaka station. They are yards east of Nada station, at the beginning of the Kōbe overhead system, and at Kōbe and Hyōgo station. The Hyōgo dock yard area has smaller yards.

(*h*) *Shops.* Hamamatsu has the third largest shops in Japan, located 1¼ miles southwest of the station. The Nagoya shops on the southwest side of the railroad are a primary objective. There are shops at Suita, north of Ōsaka. The "Kisha Seizo" in northwest Ōsaka is one of the principal locomotive- and car-building shops in Japan. There are shops at Takatori (Kōbe).

(*i*) *Roundhouses and enginehouses.* Hamamatsu, Inazawa (north of Nagoya), Nagoya (2), Takatori (Kōbe).

(*j*) *Vulnerable points.* Southeast of Okazaki, there are retaining walls along the line. At Ogaki, an additional locomotive is added to each limited express, and detached when the train emerges from the tunnel west of Sekigahara. Between Ōtsu and Ōsaka there are 3 tunnels and 2 bridges.

(*k*) *Bridges.* The Bentenjima bridge is a long bridge and causeway over Hamada Lagoon. The Tenryū-gawa bridge is said to be the most vulnerable section on the Tōkaidō line. The bridge over Shonai-gawa northwest of Nagoya is called a primary objective. The bridge over the outlet of Biwa-kō (lake) is very vulnerable because the current and depth of the stream make replacement difficult. In Ōsaka and Kōbe the Tōkaidō runs on elevated structures. There are 141 bridges between Tōkyō and Kōbe, 25 in the area of study. Following are the important bridges:

NAME OR RIVER	KM. FROM TŌKYŌ	DESCRIPTION
Tenyrū-kawa No. 2 somewhere between Nakaizumi and Tenryū-kawa	245.9 to 252.7	2 one-track bridges, 1,209 m. long; 19 spans. Parker trusses on masonry piers. Carries telephone cable. Preceding the bridge is a mile-long causeway over the lagoon.
Bentenjima	269.8	Causeway and bridge across Hamada Lagoon; about 3 mi. long.
Kiso-gawa at Gifu	396.3	848.4 m. long, 14 spans, each 60 m. long, plate girder, supported by 13 caisson piers, single-track.
Ibi-gawa at Ōgaki	410.0	15 spans, each 60 m. long. Plate girder, 15 piers resting on caissons. Single-track.
Viaduct at Maibara	445.9	2-track, 3′6″ gauge, reinforced concrete. Deck slab supported by longitudinal beams.
Yodo-gawa at Ōsaka	556.4	Total length 540′; steel truss on 2 concrete abutments, 32′ wide, 30′ high, 80′ above river.
Elevated Line, Ōsaka	556.4	Length, 1.6 km. Plate girders. Carries 4 lines of government railways.
Ōsaka, Joto (Ōsaka city belt line)	556.4	Viaduct, 2- and 3-track, reinforced concrete, carried on 3-column bents. Footings of 36 Takechi reinforced concrete piles per bent. Footings continuous.
Kōbe, viaduct (Figure VII - 21)	589.5	Total length 4.8 mi. Reinforced concrete on square columns. Begins at Nada. Crosses wide street by means of girder bridges. Ends at Takatori station in Kōbe.

(*l*) *Tunnels.* There are 24 major tunnels between Tōkyō and Kōbe, 4 of them in the area under study. These 4 tunnels are:

1. MAKINOHARA TUNNEL, between Hamamatsu and Takatsuka, 998 meters long.

2. TUNNEL NEAR GOYU (302 kilometers from Tōkyō).

3. OSOKAYAMA TUNNEL, between Ōtsu and Anju, 2,326 meters long, 1% grade.

4. HIGASHIYAMA TUNNEL, between Anju and Kyōto, 1,856 meters long, brick lining, ventilated by fan in east tunnel, grade 0.667%.

(*m*) *Branch lines.*

1. RECENT MAPS show a single-track line between Kakegawa and Futagawa, built to avoid the crossing of Hamada Lagoon.

2. AT NAGOYA, the Chuo line runs northeastward.

3. THE KANSAI line runs west from Nagoya to Ōsaka.

4. THE TAKAYAMA line runs east and northeast from Gifu to the Hokuriku line at Toyama.

There is a long plate girder and truss bridge with concrete piers across the Hida-gawa (67 kilometers from Gifu), and another bridge beyond Takayama. There is an enginehouse at Takayowa.

5. AT MAIBARA, the Hokuriku line runs north.

6. AT KUSATSU, a 36-kilometer line runs southeast to join with the Kansai at Higashisuge. This branch has 3 bridges.

7. FROM KYŌTO, a line runs south to Nara and southwest to Wakayama.

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8. AT KYŌTO the Sanin line runs west to Shimonoseki.

9. AT ŌSAKA the Kansai line runs east to Nagoya.

10. AT ŌSAKA, a line runs south to Wakayama.

11. AT KANZAKI, a single-track line runs northwest to join the Sanin at Fukuchiyama. Between Takedao and Sanda, this line crosses 3 or 4 large steel bridges and goes through several tunnels. There is an enginehouse at Sanda.

12. AT KŌBE, the Tōkaidō line merges with the Sanyō line.

(*n*) *Traffic.* In 1940, 102 passenger trains went through Gifu every 24 hours, 80 of them on the Tōkaidō line. Passenger trains on this line go to Ōsaka station on the east side of Yodo-gawa; freight trains use a cut-off which does not cross the river.

(10) *Chuo line* (*Line K*).

(*a*) *Termini.* Nagoya and Nagano.

(*b*) *Length.* 252 kilometers (157 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Grades.* The maximum grade is 2.5%.

(*e*) *Power.* Steam.

(*f*) *Yards.* Nagoya has flat switching type.

(*g*) *Shops.* Nagoya, Nagano (outside the area of this study).

(*h*) *Bridges.* There are 30 major bridges on this line. The following are over 100 meters long:

RIVER OR NAME	KM. FROM NAGOYA	DESCRIPTION
Shonai-gawa	84	Length, 99 m.; 3 spans, each 24 m. long, 2 spans, each 9 m. Plate girder, abutments masonry, foundation concrete.
Kiso-gawa No. 1	84	Length, 140 m.; 1 span of 92 m., 2 spans, each 24 m. Stone abutments, concrete foundation.
Kiso-gawa No. 2	97	Length, 128 m.; 1 span of 92 m., 2 spans, each 18 m. Plate girder, stone abutments, concrete foundation.
Ina River	111	Length, 128 m.; 2 spans, each 46 m., 2 spans each 18 m. Abutment and piers, masonry; concrete foundation.
Namera-gawa	123	Length, 118 m.; 1 span of 21 m., 2 spans, each 12 m. Plate girder, masonry abutments and piers, concrete foundation.
Shinchaya-gawa	128	Length, 101 m.; 4 spans, each 18 m., 1 span of 21 m. Plate girder, masonry abutment and piers, concrete pile foundation.

(*i*) *Tunnels.* There are 12 major tunnels on this line. Tunnels over 100 meters long are:

NAME OR MOUNTAIN	KM. FROM NAGOYA	LENGTH IN METERS
Kamikane No. 2	91	354
Mt. Jizo	95	322
Junikawara	104	182
Mt. Seki	111	149
Mt. Naka	112	316
Nezama	123	181
Nakahira	131	167
Torri	147	1,673

(*j*) *Branch lines.* A branch runs north from Tajimi to the Takayama line at Ōta.

(11) *Kansai line* (*Line L*).

(*a*) *Termini.* Ōsaka (Minatomachi station) and Nagoya.

(*b*) *Length.* 175 kilometers (109 miles).

(*c*) *Gauge and track.* 3′6″; single-track, except section of double-track between Minatomachi and Nara.

(*d*) *Power.* Steam.

(*e*) *Yards.* Nagoya has flat switching type yards. Hirano (8 kilometers from Minatomachi) has yards.

(*f*) *Shops.* Nagoya.

(*g*) *Roundhouses.* Kameyama.

(*h*) *Bridges.* The steel bridges over the 2 branches of Shonai-gawa are listed as primary objectives. There are 2 long steel bridges about 1.6 miles apart across Kiso-gawa and Ibi-gawa east of Kuwana. A bridge, 864 meters long, crosses Kiso-gawa. It is a multiple web Warren truss bridge, with 13 spans, each 61 meters long, and 1 span, 37 meters long. The deep, swift Kiso-gawa would make repairs difficult. The bridge over Kizu-gawa, a short distance east of Kasagiyama, is 166 meters long. It is a 60° skew Pratt bridge, designed for a total load of 1 ton per foot of span. It has 1 span of 61 meters; 2 spans, each 31 meters long; and 2 spans, each 21 meters long. A 3-span truss girder bridge, probably on concrete piers, crosses the Satsuki River, 2½ miles west of Shimagawara.

(*i*) *Tunnels.* There are 4 major tunnels on this line.

(*j*) *Branch lines.*

1. AT KAMEYAMA, the Sangū line runs 72 kilometers south to Toba. It is 3′6″ gauge, single-track. There is a classification yard at Tsu and a roundhouse at Matsuzaka. This line has 6 major bridges. Those over 100 meters long are: the Miya river bridge, 437 meters long; Shioai river bridge, 171 meters long, with 7 spans, each 21 meters long, and 1 span of 9 meters, plate girder with wall foundations. The tunnel at Futami is 350 meters long.

2. AT HIGASHITSUGE, a line goes northwest to join the Tōkaidō main line at Kusatsu.

3. AT KIZU, the Nara line runs north to Kyōto, crossing the Nara river on a concrete bridge.

4. AT KIZU, the Katamachi line goes west to Ōsaka.

5. AT ŌJI, a single-track branch goes south and west to Wakayama and from there south on the Kisei West line to Tsubaki, a total distance of 246 kilometers. There are enginehouses at Gojō and Wakayama. There are 6 major bridges on these lines. The bridge across Arita-kawa (129 to 137 kilometers from Nara) is a plate girder deck bridge, with masonry piers.

6. EAST OF MINATOMACHI station, the double-track branches, a line going northwest to Ōsaka.

7. EAST OF MINATOMACHI station, a line goes south to Wakayama.

(12) *Hokuriku line* (*Line M*).

(*a*) *Termini.* Maibara and Miyauchi.

(*b*) *Length.* 437 kilometers (272 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Maibara has flat switching type yards.

(*f*) *Shops.* Kanazawa (outside limits of this study).

(*g*) *Enginehouse.* Tsuruga.

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(*b*) *Vulnerability.* At Suizu (61 kilometers from Maibara), the line is subject to landslides.

(*i*) *Tunnels.* There are 21 major tunnels on this line, of which 2 are in the section under discussion. The Yanegase tunnel (32 kilometers from Maibara) is 1,352 meters long, and has a 2.5% grade. It is a semi-circular brick arch, 15½ feet high, and has masonry side walls. A new Tsukasa tunnel, 346 meters long, was completed in 1943 at a point 65 kilometers from Maibara.

NOTE: Recent information states that a new line is being built in this area, but its route is uncertain. One source states that the line goes northwest of Biwa-ko (lake). It is said to join the old line near the Arawase tunnel. Another source says it is a new electric line paralleling the old Hokuriku line. The new Tsukasa (also called Shinfukasaka) tunnel on this new line is the fourth largest in Japan, and is said to be 3.3 miles long.

(13) ***Tokushima line*** (***Shikoku***) (***Line P***).

(*a*) *Termini.* Tadotsu and Tachibana.

(*b*) *Length.* 147 kilometers (91 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Power.* Steam.

(*e*) *Yards.* Tokushima.

(*f*) *Shops.* Tokushima has small but important repair shops.

(*g*) *Bridges.* There are 18 bridges on this line (assumed from fact that line crosses river). A bridge, 572 meters long, is assumed at Yoshino-gawa (40 kilometers from Tadotsu), and one 300 meters long is assumed at the Anafuki river (74 kilometers from Tadotsu). The bridge over the Yamanu river (88 kilometers from Tadotsu) is of reinforced concrete, and is 165 meters long, with 16 spans, each 9 meters long.

(*h*) *Tunnels.* There are 5 major tunnels between Tadotsu and Tachibana. The longest is the Inohano tunnel (29 kilometers from Tadotsu), 3,845 meters long. The other tunnels are:

KM. FROM TADOTSU	LENGTH IN METERS
34	400
34	700
35	600
36	300

(*i*) *Branch lines.* At Ikeda, a line goes south to Ōtsu and then west to Susaki, a total distance of 125 kilometers. There are 22 major bridges on this branch, many of them assumed from the fact that the line crosses a river. The most important are: Yoshino-gawa bridge No. 2 (6 kilometers from Ikeda), 500 meters long; Iya-gawa bridge (11 kilometers from Ikeda), truss type, center span 46 meters long. There are 29 major tunnels on this line, 7 of them more than 1,000 meters long, and 2 of these about 2,100 meters long. Tunnels over 100 meters long are:

KM. FROM IKEDA	LENGTH IN METERS
1	483
5	644
6	241
14	965
16	482
17	322
18	322
19	1288
22	322
23	2108
25	1405
29	482
34	805
38	161
39	482
44	645
48	161
50	161
55	482
56	1391
58	161
61	322
61	1121
63	1127
64	161
65	804
116	2092
119	482
120	161

(14) ***Yosan line*** (***Shikoku***) (***Line Q***).

(*a*) *Termini.* Takamatsu to Ōtsu-Ozu.

(*b*) *Length.* 249 kilometers (155 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Rails.* 45 and 60 lbs.

(*e*) *Power.* Steam.

(*f*) *Yards.* Takamatsu has extensive yards. Tadotsu has extensive yards of 3 railroad lines.

(*g*) *Shops.* Tadotsu has small but important repair shops.

(*h*) *Enginehouses.* Tadotsu.

(*i*) *Vulnerable points.* Wakamatsu is the terminal for the car ferry to Tamano on Honshū.

(*j*) *Bridges.* There are 18 bridges on this line (assumed from fact that the line crosses rivers). The Ashite river bridge, between Ōtsu and Yawaiahama, is 46 meters long, and is of Pratt truss construction.

(*k*) *Tunnels.* The Inohama tunnel on this line is 3,845 meters long (location unknown).

(*l*) *New lines.* It is reported that this railroad extends from northeast of Ōtsu to Uwajima, where it connects with the short section which already existed between Uwajima on Matsumaru. On this new line there is a tunnel between Uwa and Yoshida. It is also reported that this line was being extended from Uwajima to Hirajo.

(15) ***Kotoku line*** (***Shokoku***) (***Line R***).

(*a*) *Termini.* Takamatsu and Tokushima.

(*b*) *Length.* 75 kilometers (47 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Rails.* 45 and 60 lbs.

(*e*) *Power.* Steam.

(*f*) *Yards.* Takamatsu and Tokushima.

(*g*) *Shops.* Tokushima has small but important repair shops.

(*h*) *Bridges.* Total of 16 bridges, assumed from fact that the line crosses rivers. The Yoshino-gawa bridge at Tokushima is a very long one.

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(*i*) *Branch lines.* Ikenotani to Muya, 8 kilometers long. Two bridges on this line.

(16) ***Awaji line.***

(*a*) *Termini.* Fukura and Sumoto (Awaji).

(*b*) *Length.* 23 kilometers (14 miles).

(*c*) *Gauge and track.* 3′6″; single-track.

(*d*) *Rails.* 30 and 40 lbs.

(*e*) *Power.* Steam.

(*f*) *Rolling stock.* Probably has 6 steam locomotives.

(17) ***Private railroads of the Kyōto-Ōsaka-Kōbe area*** (FIGURE VII - 3).

(*a*) *Nara Electric Railway.*

1. TERMINI. Kyōto and Saidaiji.

2. LENGTH. 35 kilometers (22 miles).

3. GAUGE AND TRACK. 4′8½″; double-track.

4. POWER. Electricity. Has 3 substations. Current distributed as 600 volts, d. c. Contact system is overhead, single catenary.

5. ROLLING STOCK. 24 passenger cars, 5 freight cars.

6. YARDS. Kyōto yards serve this line.

7. BRIDGES. Across Kizu-gawa.

(*b*) *Keihan Railroad.*

1. TERMINI. Ōsaka (Temma station) and Kyōto (Sanjo station).

2. LENGTH. 48 kilometers (30 miles).

3. GAUGE AND TRACK. 4′8½″; double-track.

4. RAILS. 60, 103, and 108 lbs.

5. POWER. Electricity. Bulk supply from Ōsaka Light Company, Daido Electric Power Company, and other power stations. This supply may have been replaced by 2 hydroelectric stations on Hidaka-kawa, of 1,950 and 4,500 kw. capacity, and on the Funatsu river, 750 kw. Also 2 steam plants: Kotonoura, 5,000 kw. and Tobira, 2,000 kw. There are 7 substations. Contact system is overhead, single or compound catenary.

6. ROLLING STOCK. 100 passenger cars, 24 freight cars.

7. BRIDGES. There are 2 major bridges on this line.

8. BRANCH LINES. Kyōto (Sanjo station) east to Ōtsu, 11 kilometers; Ōtsu to Sakamoto and Ishiyamadera, 14 kilometers; Chushojima southeast to Uji, 4 miles.

NOTE: This line runs east of Yodo-gawa. It should not be confused with the Shin-Keihan Line which runs west of the river.

(*c*) *Shin-Keihan Railroad.*

1. TERMINI. Ōsaka and Kyōto.

2. LENGTH. Approximately 48 kilometers (30 miles).

3. GAUGE AND TRACK. 4′8½″; double-track.

4. RAILS. 60 lbs.

5. POWER. Electricity. There are 2 substations. Contact system is overhead, compound catenary.

6. BRIDGES. 2 bridges on this line.

7. BRANCH LINES. Awaji to Senriyama, Katsura to Arashiyama.

NOTE: This line is west of Yodo-gawa.

(*d*) *Nankai Electric Railway.*

1. TERMINI. Ōsaka (Namba station) to Wakayama.

2. LENGTH. 64 kilometers (40 miles).

3. GAUGE AND TRACK. 3′6″; double-track.

4. RAILS. 50 and 60 lbs.

5. POWER. Electricity. Has 4 steam power stations and 12 substations. Current distributed as 600 volts, d.c. (may have been changed to 1,500 volts, d.c.) Contact system is overhead, single catenary.

6. ROLLING STOCK. 20 electric locomotives, 7 steam locomotives; 35 steam passenger cars, 155 electric passenger cars (Total: 206 passenger cars in 1936); 504 steam freight cars, 1 electric freight car (Total, 518 freight cars in 1936); 80 bogie tramway cars; 4 water sprinklers.

7. BRIDGES. One major bridge north of Wakayama over Kino-kawa.

8. BRANCH LINES. Kōya branch, Shiomibashi station south to Hashimoto and Koyasan, 34.4 miles, double-track for the first 10 miles; Hankai branch, Ebisucho station south to Sakai and Hamadera, 9.7 miles, double-track: Hirano branch, Ebisucho station southeast to Hirano, 3.6 miles; Uyemachi branch, Tennoji station south to Sumiyoshi, 2.9 miles.

NOTE: This line runs west of the Hanwa Railroad.

(*e*) *Hanwa Railroad.*

1. TERMINI. Ōsaka (Tennoji station) and Wakayama.

2. LENGTH. 61 kilometers (38 miles).

3. GAUGE AND TRACK. 3′6″; double-track.

4. POWER. Electricity. Has 3 substations, current distributed as 1,500 volts, d.c. Contact system is probably overhead, single catenary.

5. ROLLING STOCK. 48 passenger cars, 126 freight cars.

6. BRIDGES. One major bridge northeast of Wakayama over Kino-kawa.

7. TUNNELS. One tunnel 7 miles northeast of Wakayama.

8. BRANCH LINES. Otori west to Hamadera, 1 mile; Wakayama to Kakawa, 9 miles.

NOTE: This line runs east of the Nankai Railroad.

(*f*) *Ōsaka Railroad.*

1. TERMINI. Ōsaka (Tennoji station) and Kumadera, via Takadacho.

2. LENGTH. 40 kilometers (25 miles).

3. GAUGE AND TRACK. 3′6″; double-track.

4. RAILS. 40 and 60 lbs.

5. POWER. Electricity. Has 3 substations. Current distributed as 1,500 volts, d.c. Contact system is overhead, suspension method not known.

6. ROLLING STOCK. 4 locomotives, 13 motorcars with 4 motors of 100 hp. each, and 67 other motorcars.

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7. BRANCH LINES. Furuichi south to Nagano, 12 kilometers.

(*g*) *Daiki Railroad.*

1. TERMINI. Ōsaka (Sakuranomiya station) to Nara.

2. LENGTH. 31 kilometers (19 miles).

3. GAUGE AND TRACK. Double-track.

4. POWER. Electricity. Has a power station with 2,000-kw. capacity and 2 substations.

5. ROLLING STOCK. Motorcars equipped with 160-hp. motors.

6. TUNNELS. 8 miles east of Ōsaka is a double-track tunnel, 3,380 meters long. The upper part is lined with a brick arch. The walls are of brick, concrete, or masonry, 5 to 8 feet thick with a concrete backing 2 to 3 feet thick. Short tunnel 2 miles east of main tunnel.

NOTE: The Sangū Line has used 40 kilometers of this line's track from Ōsaka.

(*h*) *Sangū line* (*Line N*).

1. TERMINI. Ōsaka (Uehommachi station) and Uji-Yamada.

2. LENGTH. 137 kilometers (85 miles).

3. GAUGE AND TRACK. 4′8½″; single-track, except for double-track from Sakurai to Nabari (28 kilometers), and Nakagawa to Uji-Yamada (28 kilometers).

4. RAILS. 75 lbs.

5. POWER. Electricity. This line used 40 kilometers of the Daiki track out of Ōsaka to Sakurai. Gets bulk supply of power for east end of line from Godo Denki K.K. in Ise district; Daiki line supplies power for west end. There are 5 substations. Contact system is overhead, single catenary compound system.

6. ROLLING STOCK. 35 motorcars with 4 motors of 200 hp. each; 18 motorcars with 4 motors of 150 hp. each; 10 other motorcars; 4 freight motorcars with 4 motors of 150 hp. each.

7. BRIDGES. 132 bridges on this line, including several overpasses over the Kansai Line. Main bridges: over Miya-gawa at Ise, 437 meters long; Kanda-gawa, near Murouguchi station, 150 meters long, reinforced concrete, 150 feet above stream; Sangenga bridge at Kamitsu, 97 meters long, reinforced concrete, 150 feet above the stream.

8. TUNNELS. 16 tunnels on this line. Longest is the single-track Aoyama tunnel, 3,432 meters long, between Sakurai and Matsuzaka.

9. BRANCH LINES. Nakagawa to Kuwana and Nagoya; Uji-Yamada to Tsu, 41 kilometers; Kumadera-Yoshino, 25 kilometers; Sakurai-Hase, 6 kilometers.

(*i*) *Joto line.*

This is a freight belt line in Ōsaka, which runs from Umeda station east 2 miles, south 4 miles, and west 1½ miles to Tennoji station. It is on a concrete viaduct, is electrified, and double-track.

(*j*) *Hankyu* (*Hanshin Express Electric*) *Railroad.*

1. TERMINI. Ōsaka (Umeda station) to Kōbe.

2. LENGTH. 33 kilometers (21 miles).

3. GAUGE AND TRACK. 4′8½″; double-track.

4. RAILS. 60 and 93 lbs.

5. POWER. Electricity. Power station at Nishinomiya, 15,000 kw. capacity. There are 8 substations. Contact system is single or compound catenary.

6. ROLLING STOCK. 107 motorcars, 15 freight motorcars.

7. BRIDGES. Crosses 5 major bridges. Longest is over Yodo-gawa in Ōsaka.

8. BRANCH LINES. Tsukaguchi to Itami; Nishinomiya to Takarazuka; Juzo to Noseguchi and Takarazuka.

NOTE: This line runs north of the Tōkaidō Line. Within Kōbe it is elevated on a concrete viaduct from Nada station to its terminal. Crosses wide streets on girder bridges. This is a passenger line, but it also carries some freight. During the day, express trains of from 2 to 4 cars run every 10 minutes, and ordinary trains every 4 to 6 minutes. The expresses make the run from Kōbe to Ōsaka in 25 minutes; ordinary trains, in 36 minutes.

(*k*) *Hanshin Electric Railroad.*

1. TERMINI. Ōsaka (Umeda station) and Kōbe (Montomachi station).

2. LENGTH. 32 kilometers (21 miles).

3. GAUGE AND TRACK. 4′8½″; double-track.

4. RAILS. 60 and 100 lbs.

5. POWER. Electricity. Power station at Amagasaki, 19,600 kw. capacity; Higashihama station, 11,500 kw. Contact system overhead, single or double line.

6. ROLLING STOCK. 140 motorcars with 4 motors of 50 or 60 hp. Branch lines have 35 motorcars; Hanshin Kokudo, the electric tramway to Amagasaki city, 35 motorcars.

7. BRIDGES. The line crosses 5 major bridges. In Ōsaka, the line has two branches, each of which crosses Yodo-gawa on a double-track bridge.

8. TUNNELS. Goes underground in eastern Kōbe to its terminal.

(*l*) *Kōbe-Himeji Railroad.*

1. TERMINI. Kōbe and Himeji.

2. LENGTH. Approximately 45 kilometers (28 miles).

3. GAUGE AND TRACK. 4′8½″; single-track.

4. RAILS. 60 and 114 lbs.

5. POWER. Electricity. Two steam power plants at Akashi-shi and Shioya, total capacity 2,300 kw., and current purchased from 2 power plants. Contact system is overhead, cross suspension, single catenary.

6. ROLLING STOCK. 44 passenger cars. An additional 24 cars were on order in 1943.

7. BRIDGES. There are 2 major bridges on this line.

8. BRANCH LINES. May have been extended from Shikama (south of Himeji) westward to Aboshi.

NOTE: This line runs through the main streets of western Kōbe for about a mile before turning to run alongside the road. This was formerly an amusement line, but its freight traffic is increasing.

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72. *Roads and Trails*

A. General.

Japan lags far behind other important nations in the development of a road system adequate for motor traffic. Three factors are chiefly responsible: the rugged nature of the land itself, the location of all major cities and densest areas of population along seacoasts abounding in good harbors, and the prior claim of railroads on the public attention. There has been a resultant emphasis on the development of both coastal shipping and railroads and a neglect of road building. Although the coming of commercial motor vehicles has caused an acceleration of road construction during the past 2 decades, average roads in Japan are still not "motorable" by western standards. Good paved highways are found in the vicinities of the large urban areas, and the main national highways are generally motorable, but there is no real uniformity in the surfacing or condition of the roads. Of approximately 600,000 miles of roads, probably about 1/6 could be considered all-weather and motorable. Much of the remaining mileage consists of narrow roads suitable only for bicycles, carts, motorcycles and horses, and possibly jeeps. Lack of adequate air reconnaissance and other reliable information at this time makes impossible any attempt at detailed route description.

(1) *The road pattern.*

Southwest Japan is divided morphologically into an inner zone and an outer zone. The boundary between these regions is a very noticeable fault, cutting through the center of Kyūshū, northern Shikoku, and Kii-hantō on Honshū. North of this line, the topography is hilly rather than mountainous, much the larger part being under 1,000 meters. Lowlands of conspicuous size are largely lacking, the Ōsaka-heiya (plain) being the largest (FIGURE VII - 4). Minor alluvial fragments, occupying small coastal indentations, are characteristic.

The Pacific folded mountain region, south and east of the fault line, is a region of relatively high and rugged folded mountains and hill country. Well developed longitudinal valleys and ridges follow the axes of the folds and extend in a general northeast—southwest direction. Flat upland surfaces are rare; river valleys are narrow, steep-sided, and characterized by entrenched meanders.

The pattern of main roads in Japan reflects the effect of these topographic features upon the economic development of the country. On the island of Honshū, most of the major cities lie on the eastern or southern coasts, looking toward the Inland Sea or the Pacific Ocean. Shikoku, in contrast, turns its mountainous back toward the ocean and its face toward the Inland Sea. Kyūshū likewise is backed by the ocean and faces its neighbors on the mainland. In response to this development, the main national highway on Honshū leads westward from Tōkyō to Yokohama, Nagoya, Kyōto, Ōsaka, Kōbe, Okayama, and Shimonoseki. The main highway on Kyūshū is an extension of this road, and proceeds around the island as a coastal highway with numerous branches in the northern industrial area. The main highway on Shikoku roughly parallels the Inland Sea.

In general, the roads follow the coasts and river courses and fan out on the occasional plains (FIGURE VII - 3). The general pattern is one of coastal roads tied together by cross-island routes (FIGURE VII - 59). Roads are more numerous on Honshū and northern Kyūshū than in the Pacific folded mountain region of Kii-hantō (Honshū), southern Shikoku, and southern Kyūshū, but road building is difficult throughout the area (FIGURE VII - 36). Innumerable tunnels are required both along the cliff sections and in the mountain regions (FIGURE VII - 37). Many areas are practically without roads because of the difficulty of construction. In general, the roads parallel the railroads, although some roads afford access to steep mountain areas inaccessible to railroads (FIGURES VII - 58 and VII - 59).

(2) *Effect of elements on road transport.*

Located in a monsoon and typhoon area, Southwest Japan is subject to periods of extensive precipitation, which cause washouts, landsliding, and muddy conditions along roads and trails. In most of Japan, the rainy season occurs in the summer. From June through the end of July, the light but steady monsoon rains of this season, the *bai-u* or "plum rains," seriously affect the state of transit routes.

Roads at the base of cliffs are in particular danger from landslides at the times of typhoons and earthquakes. Typhoons, characterized by extremely heavy downpours, affect the area during August and September on an average of 5 to 10 annually. Transit routes in Southwest Japan are exposed to the danger of earthquakes on the average of once every 3 years.

FIGURE VII - 36. *Shikoku.*
Typical hairpin turns through a mountain pass on the Matsuyama-Ikeda road.

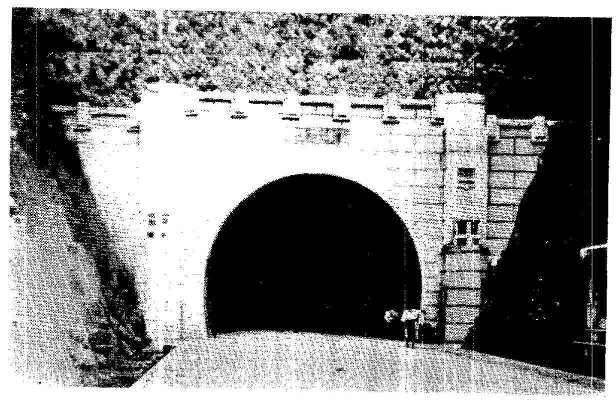

FIGURE VII - 37. *Nagasaki vicinity.*
Vehicular tunnel. Construction typical of the many road tunnels in Japan.

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In western Honshū, the dangers of landslides and washouts are greatest in the area bordering the Japan Sea. Here the precipitation maximum is reached in December during the northerly monsoon, which brings almost daily snows and resultant traffic tie-ups. In the Pacific coast region, tropical cyclones bring their heavy rainfall in September, causing considerable restriction of traffic due to landslides, washouts, and extreme muddiness.

In general, weather conditions favor the movement of overland traffic throughout Southwest Japan in early spring, when relatively little rain falls. Along the Pacific coast, fine weather also prevails during the winter months. In the Inland Sea district, as well, roads and trails are open to traffic throughout the winter months, but periods of snow or rain may be expected whenever the monsoon shifts a little west and blows over the sea. The Japan Sea region is a dreary, clouded, stormy area during most of the year; only in the months of May and October are roads dry enough to be passable without danger of landsliding and washouts.

The following table (TABLE VII - 6) shows the significance of climate to road conditions at 3 selected weather stations.

TABLE VII - 6.
RAIN FREQUENCY AND SNOW COVER AT SELECTED STATIONS.

PLACE	WEATHER FACTOR	MONTHS OF MOST FREQUENT OCCURRENCE	MONTHS OF LEAST FREQUENT OCCURRENCE
Nagoya	Rain frequency	June-July; Sept. (15-16 days/mo.)	Nov.-Feb. (9-10 days/mo.)
	Snow cover	Dec.-Feb. (2-3 days/mo.)	Apr.-Oct. (None)
Shimonoseki	Rain frequency	Dec.-Mar.; June (15-17 days/mo.)	Aug.-Oct. (10-11 days/mo.)
	Snow cover	Jan.-Feb. (2 days/mo.)	April-Nov. (None)
Nagasaki	Rain frequency	All months. (10-16 days/mo.)	
	Snow cover	Jan.-March (1-2 days/mo.)	April-Nov. (None)

(3) ***Terrain adjacent to roads.***

(*a*) *Cover.* Southwest Japan, like the rest of Japan, is richly forested and offers, in varying degrees from region to region, suitable cover for the concealment of motor transport. Sixty per cent of Japan is classified as wooded country, but 15% is actually wild land, covered only by grass and shrubs.

That part of Honshū which lies north of the thirty-seventh parallel is in the temperate forest zone, with broad-leafed deciduous trees such as the beech, ash, chestnut, poplar, oak, and kayaki providing cover where the rugged, mountainous terrain permits deployment.

In the southern or sub-tropical forest zone, which includes southern Honshū and the islands of Kyūshū and Shikoku, roads and trails are flanked by forests of evergreen broadleafed trees gradually being supplanted by the broad-leafed deciduous variety. Oak trees are dominant with bamboo, camphor, and hazi flourishing. However the Sanyō district (southern Chūgoku, facing the Inland Sea), an area composed largely of granite hills with only meager vegetation, affords poor cover even for small units. Thick groves of bamboo, which parallel the rivers of the Biwa-ko area, provide limited ground concealment where the shoots grow far enough apart to permit access to motor units. Extensive fruit orchards on the Kyōto plain and the orange- and mandarin-growing regions of the Ōsaka plain furnish possible concealment, depending on the size of the groves. Tea gardens blanket the hill slopes throughout the area, but are most abundant between Kyōto and Nara. They afford little cover, as they generally reach only five to six feet in height and resemble hedges in the thickness of their growth. In southern Kyūshū, palms and banana trees offer adequate concealment from the air and from the ground. Flat-bottomed, steep-walled valleys, often mantled in dense sub-tropical evergreen forest, may also afford suitable cover for motor transport. Southern Shikoku's rich forest land offers ground and air concealment where hilly or mountainous terrain allows deployment. (A more detailed description of terrain is given in CHAPTER II, 21.)

(*b*) *Deployment.* Throughout Southwest Japan, movement across country for any considerable distance is uncertain and difficult. Deployment from the main road network in almost every section is limited by the hilly or mountainous terrain adjacent to the routes. The scattered plains, which are almost entirely devoted to rice cultivation, resemble huge lakes in spring and early summer and remain soft all year, preventing deployment by wheeled vehicles. These large rice paddy fields characterize the lowlands, valley floors, and terraced hillsides of the Sanin Littoral of the Japan Sea, the borderlands of the Inland Sea, northern Kyūshū, and the southern sections of both Kyūshū and Shikoku (where rice is planted twice a year). Medium tanks could operate through rice fields, but other motor units would be restricted to the narrow, winding, raised dirt roads skirting the rice field areas.

Sand beaches which border some of the plains have beach ridges and sand dunes for several hundred yards inland, a condition which would reduce deployment somewhat. Low, swampy lagoons and marshes between the ridges and dunes make movement from roadways hazardous.

Roads and trails through the rugged mountainous interiors lack conditions for deployment. The steep-walled valleys, very often covered with dense undergrowth (especially in southern Kyūshū), are unsuited to cross-country movement. Roads in the rugged areas frequently follow the typical, short, swift, boulder-strewn streams, which are difficult to cross except by bridge.

The thick bamboo groves common in the basin district of Honshū might offer considerable resistance to vehicles moving across country. The abundant fruit orchards might permit deployment by small motor units in those places where trees are planted a considerable distance apart.

Coastal roads, especially on Honshū, frequently run along the wave-cut cliffs backed by steep hills. Deployment is impossible along many stretches of this type (FIGURE VII - 38).

(4) ***Road building materials.***

Japan has no lack of road building material, good natural rock and domestic cement being plentiful. Bitumen and tar, necessary for giving roads a durable surface, are, however, available only in limited quantities. Bitumen distilled from the oil shale of Manchuria, and road tar provided by the coal industry have not sufficed to meet the needs. Concrete is widely used for the construction of new roads.

Because of the scarcity of surfacing materials, only the important roads are hard-surfaced. Rural communities are served by narrow dirt roads, raised several feet above the surrounding area.

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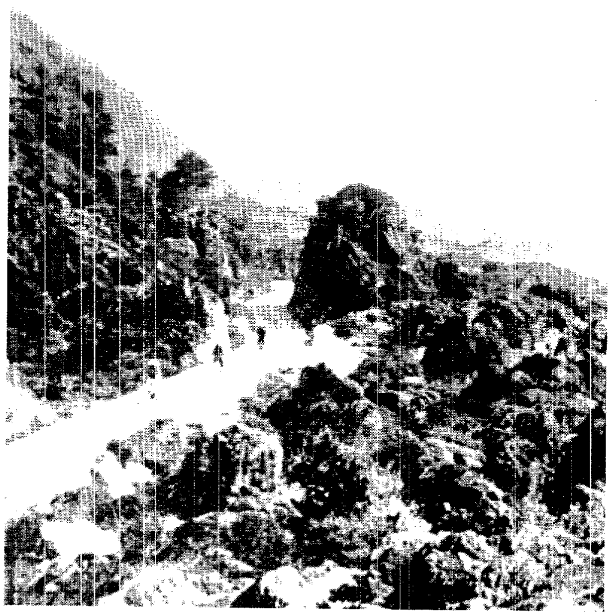

FIGURE VII - 38. *Muroto-zaki (cape), Shikoku.* View of road along the shore. This is typical of many stretches of coastal highway.

There is a great deal of rock which could be crushed for road material in all parts of Kyūshū. The most common types are: granite, andesite, basalt, metamorphic crystallines, and other lavas. Granite and andesite are the most widely distributed. Limestone has been quarried at O-tsuki-shima, Gongen-yama, and at other places in Kumamoto prefecture. Gravel and sand are to be found along rivers, coasts, and in the lowlands. Sand dunes are present in some places on the seashore, notably around Kagoshima-wan (gulf) and on the western peninsula of Kagoshima.

Rock to be quarried and crushed for road material may be found in most parts of the island of Shikoku. A wide band of crystalline rock extends from Tokushima across the island to the end of Sadamisaki peninsula. Andesite is available in the northeast. There is considerable granite on the 2 northern peninsulas, on the tip of the southwest peninsula at Ashizuri-zaki, near Komame, and also east of Uwajima. Conglomerate can be found south of Yoshida in the west, inland from Kannoura in the east, and inland from Hiketa in the northeast. Limestone is found in small scattered areas in a band extending from Kannoura and Tachibana on the east coast to the general vicinity of Mikamei on the west coast. It is quarried at Ohama. There is a large amount of sandstone and shale west of Naruto (strait). Sandstone and other building stones, used as materials for pavement, are quarried in Tanokuchi-mura, Kuno-mura, and Miura-mura. Sand and gravel may be found along the coast and rivers, and in the lowlands, particularly along the shores of Tosa-wan south and east of Kōchi, along the shore of Huichinada, and at the mouth and in the valley of Yoshino-gawa.

Road material for use on Honshū is obtained from the hard, compact olivine basalt exposed at the western foot of Shira-hamayama on Shodo-shima in the Inland Sea. Quarried blocks are crushed for use as road material and shipped to Ōsaka, Kōbe, and neighboring provinces. Basalt is found in several areas on the west coast of Honshū and on the small islands in the bay near Matsue.

There is much granite, diorite, grano-diorite, and gneiss on southwest Honshū and the small islands of the western Inland Sea, granite being easily obtainable along the north shore of Setuchi behind Ube, Hiroshima, Kure, Okayama, and Kōbe. It is plentiful throughout the interior of Honshū, especially south of Matsue and on the peninsula northwest of Tsuruga. A considerable amount of grano-diorite appears south and east of Ōsaka on the Kii-hantō (peninsula). In the vicinity of Tokuyama, granite and andesite are obtained at approximately 30 quarries. Andesite is scattered generally over the northern half of southwest Honshū and throughout other areas along the shore of the Japan Sea. Limestone may be obtained in the district of Akiyoshi nearly in the center of Yamaguchi prefecture. Sand and gravel exist along the coasts and in river valleys and lowlands. There are extensive gravel deposits on the plain near Toyohashi, around Biwa-ko (lake), and along the shores of Ōsaka Bay. Diluvial terrace gravels may be found south of Ōsaka and in the Ōsaka hinterland, and along the shores of Ise-wan (bay).

(5) *Administration of highways.*

The construction and maintenance of Japanese roads was under the administration of the National Highways Bureau of the Home Affairs Ministry. The policy has dictated that the full cost of construction and maintenance of national military roads be defrayed by the national treasury. The Bureau also assumed ½ the cost of other national highways and ⅓ the cost of prefectural roads. Since the war, attempts have been made to accelerate road construction, especially of highways suitable for high-speed truck traffic. As a result, in June 1944, the right to construct such high-speed auto roads was transferred from the Home Office of the National Highways Bureau to the prefectural governments. Further encouragement has been given the construction of prefectural and municipal roads by a system of subsidies from the national treasury.

(6) *Classification and standards of construction.*

The road law which laid down the specifications for the various classes of roads was promulgated in 1919. It established certain regulations for width and gradient, as shown in TABLE VII - 7.

TABLE VII - 7.
REGULATIONS FOR WIDTH AND GRADIENT OF ROADS IN JAPAN.

CLASS OF ROAD	MINIMUM WIDTH	RULING GRADE	BRIDGE LOAD
National Highway (Koku-do)	24 feet	1 in 30 (3.3%)	12-ton road roller
Prefectural road (Fuken-do)	18 feet	1 in 25 (1 in 10 in mountain areas)	6-ton automobile
Municipal roads (Shi-do)	18 feet		
Village roads (Chosen-do)	12 feet		

Although these standards were set up, there is no over-all uniformity, and all roads do not measure up to the standards. No rules were set up for surfacing, and great variety exists from place to place. Where new roads have been constructed, especially in the vicinity of large urban areas, concrete has been

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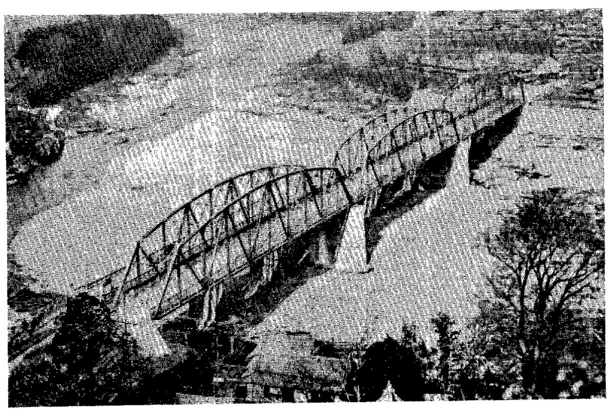
widely used. A very small number of Japanese roads are paved; in 1938, only about 15% of the national highways and 2% of the prefectural roads were paved. Most of the concrete highways are 2-lane, but there are some stretches of wider high-speed highways which have been constructed near the large cities, such as the Kōbe-Ōsaka highway. Every type of modern equipment has been used in the building of Japanese roads.

(7) *Bridges.*

Japanese bridges are the work of American- and European-trained engineers, and are therefore very similar in design and construction to the common bridge types in our own country (FIGURES VII - 39). As a result of the earthquake of 1923, much was learned as to which types could best withstand shocks. It was found that steel girder bridges were superior to reinforced concrete. For steel highway and city bridges of moderate span, tied arches and 2-hinged arches have been widely used. For spans up to 32.8 feet long, slabs or beams predominate; for longer spans, bridges of the rigid frame type and arches are frequently used. Piers and abutments were usually of concrete or reinforced concrete upon pile foundations. For deep foundations, it was the practice to use reinforced concrete caissons. Steel sheet piling has lately been extensively applied. In 1939, there were approximately 8,000 bridges on national highways, 95,000 on prefectural roads; the total number was about 400,000.



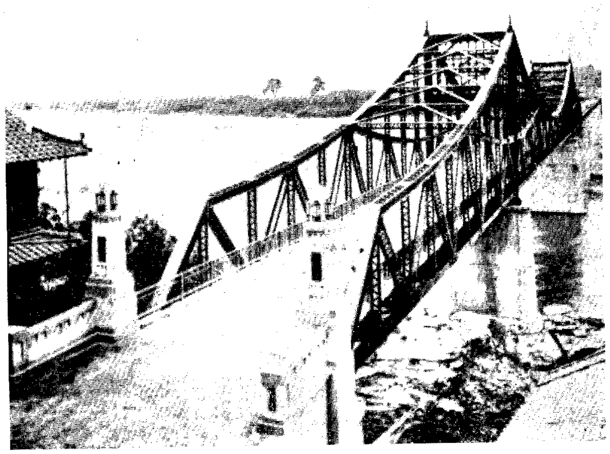


FIGURE VII - 39.
Typical Japanese steel bridges.
(a) Bridge at Kamiichi (Nara prefecture, Honshū). 1931.
(b) Bridge over Yoshino-gawa at Anabuki (Tokushima prefecture, Shikoku).

(8) *Significance of Japanese highways.*

In spite of improvement within the last 2 decades, it is safe to say that most Japanese roads are better adapted to use by small vehicles and pedestrians than to modern motor transport. Bicycles are widely used in Japan, and people travel considerable distances on them, using them even for the transportation of goods. Motorcycles, especially of the 3-wheeled variety, are also very common. In 1936, it was reported that there were about 7,000,000 bicycles and 56,000 motorcycles in the country. Small cars, similar to the Austin variety, were developed and used extensively. Most imported automobiles were of the lighter makes. In 1936, there were reported to be 74,910 passenger cars and taxis, 4,978 special cars, 51,338 trucks, and 63,348 small cars.

The war has given a considerable impetus to the use of trucks for freight transport. The government-controlled railways, which operate bus and truck lines, previously restricted the use of motor vehicles where they offered competition to the railroads. Wartime strains on railroads have caused a reversal of policy, and short-haul freight is now being handled chiefly by trucks, resulting in an expansion of road building activities. This use of trucks has been part of the program of coördinating all transportation facilities best to serve war needs. It is reported that there has been some conversion to charcoal and other substitute fuels. It is not known how much of the pressing need for fuel and rubber is being met by imports from conquered areas.

B. Kyūshū.

The one major highway of Kyūshū circles the island, following near the coast for most of its length. Branches of this highway connect the major industrial cities of the northwest, Sasebo and Nagasaki, with Kurume and Kumamoto on the main highway. These main roads are national highways, and are therefore presumably either hard- or gravel-surfaced.

In addition to the main highways, there are prefectural or second-class routes, which are mainly connecting routes and usually follow valley courses. The greatest concentration of these is in the mining and industrial area of northwestern Kyūshū. In the central section, there are fewer secondary roads, most of which are transisland routes. In the southern part of the island, there is a loose network of secondary roads serving the Kagoshima area. There are innumerable 1-way dirt roads, not shown on FIGURE VII - 59, which connect rural communities (FIGURE VII - 40). In the rice-growing regions, these roads are raised several feet above the paddies.

(1) *National highways.*

From Moji, at the northern tip of Kyūshū, the main circum-island highway extends southwest to Fukuoka, following the railway and going not more than five or six miles inland at any point. An alternate route leads south from Wakamatsu through Iizuka and joins the main highway south of Fukuoka. From Fukuoka, the road cuts inland and runs south to Tosu through an area of relatively low relief. The main route extends southward from Tosu to Kumamoto. A branch leads west from Tosu to Saga, and thence to Takeo, where it forks west to

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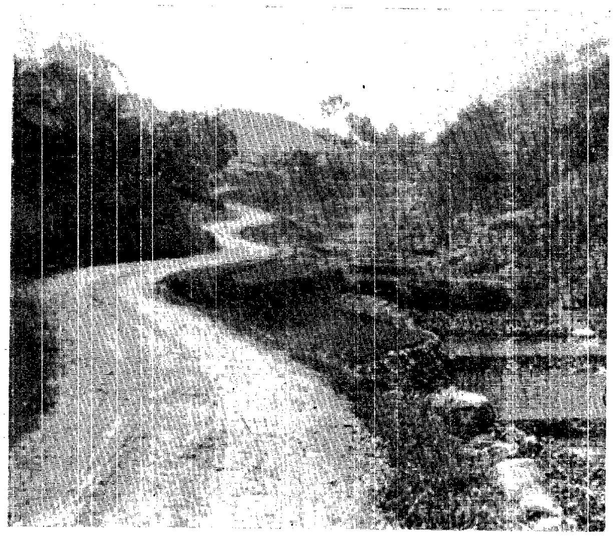

FIGURE VII - 40. *Nagasaki prefecture, Kyūshū.* View of dirt road from Nagasaki to Unsen.

Sasebo and south to Nagasaki (FIGURE VII - 59). The latter is connected with Sasebo by a coastal highway via Sonogi and Haiki. Traffic from the Nagasaki-Sasebo area can reach Kumamoto by a national highway branching southward from Saga and striking the main route just north of Kumamoto. From this point, the main road continues south, approximately 5 miles inland at most points, through Sashiki and Akune to the town of Kushikino. The road turns inland here, and runs east across the southwestern peninsula of the island to the port of Kagoshima, closely following the railroad much of the way. The highway runs close along the shore of Kagoshima bay north and east to Fukuyama; it then runs directly east to Miyakonojō, after which it follows the railroad running northeast to Miyazaki on the coast. From Miyazaki north to Nobeoka, the road and railroad lie within a mile or two of the coast (FIGURE VII - 41).

At Nobeoka, the road and railroad leave the coast, striking north to Saeki, where they again touch the coast and then cut northwest across to Ōita on Beppu-wan (bay). Following the shoreline around the bay, the highway runs close to the rail line across the peninsula north to Nakatsu.

FIGURE VII - 41. *Miyazaki prefecture, Kyūshū.* View of national highway along the coast. September 1939. View taken from a train.

The road between Ōita and Nakatsu is approximately 20 feet wide and surfaced with concrete pavement. Between Ōita and Beppu, the distance between mountains and sea is very narrow, so that the highway and railroad tracks run very close together: it was necessary to build retaining walls at the foot of the mountains. The route lies very close to the shoreline all the way from Nakatsu to the industrial city of Kokura, where it joins the Moji road, thus completing a circle of the island. Moji is connected with Shimonoseki on the island of Honshū by an underwater tunnel for cars and pedestrians.

(2) ***Secondary roads.***

Prefectural or secondary roads form a dense network connecting the coal fields and industrial areas of northern Kyūshū. In this area, there are also second-class roads which may be used as alternate routes to all national highways. Wherever the national roads run inland, there is a prefectural route which quite closely follows the shoreline (FIGURE VII - 59).

In the central section of the island, there are 5 transisland roads which join the national highway at the coast. From Kurume to Ōita, the road closely follows the rail line over moderately steep terrain.

Another prefectural route runs relatively close to a rail line from Kumamoto, which forks north just east of Ōtsu and leads to the main highway on the east side of the island at Inukai. The south fork, east of Ōtsu, runs down to Nobeoka, following Gokase-kawa (river) most of the way.

Farther south, there is a route across the island from Sashiki to a point on the east coast south of Takanabe. The terrain along this road is rough. The southernmost transisland road runs east from Minamata to Miyazaki on the east shore. The road follows the rail line to a point about 10 miles directly north of Miyakonojō, where it runs more or less due east to Miyazaki.

In the southern part of Kyūshū, there is a road following the shore line of Kagoshima-wan (bay), and a loose network of roads connecting the port of Kagoshima with its populous hinterland. Miyakonojō is also the center of a pattern of secondary roads leading to the coast and inland.

C. Shikoku.

Motor road mileage is proportionately smaller on Shikoku than on the other islands of Japan proper. A rugged terrain, characterized by mountains rising directly from the sea, and having only steep and narrow valleys, has reduced to a minimum the area suitable for easy highway construction.

There are only 2 national highways on the island; one follows the northern coastline, connecting various urban centers, and the other is a transisland highway leading from Marugame to Kōchi, the largest population center on the southern portion of the island.

The secondary roads, for the most part, follow the coastline, forming a circular pattern. Wherever the national highways do not run within a few miles of the coast, a branch secondary road connects the main road and the shore settlements. There is 1 cross-island prefectural route, but most of the interior is uninhabited and inaccessible. Numerous dirt roads and trails, not shown on FIGURE VII - 59, connect the many fishing villages with each other.

(1) ***National highways.***

Yawatahama is the western terminus of the coastal national highway. The road, following a route located several miles inland, proceeds northeast from Yawatahama to Matsuyama.

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From Matsuyama, the road leads across the Imabari peninsula to Komatsu. The highway then crosses the rail line, and both rail and motor road proceed near the coast line up to Marugame and Takamatsu, the other main center of settlement on the island. The terrain is very steep in places on this route, and the road makes several hairpin turns (FIGURE VII-42). The national highway extends a few miles past Takamatsu to Tsuda.

The transisland national highway begins at Marugame, follows the railroad more or less closely to Ikeda, and continues across steep mountains and down river valleys to Kōchi.

(2) *Secondary roads.*

On the northwestern section of the island, a prefectural road extends along the coast line of the Imabari peninsula and joins the national highway at Matsuyama and Komatsu. It serves to connect the isolated coastal settlements with the first-class main road.

Striking south from Matsuyama, the cross-island prefectural road crosses rugged interior terrain. Except where it cuts south to touch the town of Sakawa, the road follows the river valley from Ike-gawa most of the way to Kōchi (FIGURE VII-59). South from Yawatahama, a secondary road winds through Uwajima and across the island to Kubokawa. Extending south from the Kubokawa road, another route follows the Shimando-gawa (river) valley to Nakamura, the center of local roads serving the southern part of Shikoku. The roads in this area are a combination of gravel and clay. Cement sea walls have been built wherever a road touches the shoreline.

From Kubokawa, the prefectural road leads northeast to Kure and on to Kōchi, lying several miles inland most of the way. It follows the coast line rather closely down to Muroto at the southeasternmost tip of Shikoku (FIGURE VII-38). It then continues up to the eastern coast to the rail and motor road junction of Tokushima. North out of Tokushima, it crosses the mouth of Yoshino-gawa (river) and the peninsula formed by its delta and joins the national highway at Tsuda. At Bansai, this road is crossed by another, which follows a cross-island fault depression between Kawanoe and Muya. At Anabuki, the route crosses Yoshino-gawa over a large modern cantilever truss and plate girder bridge. It is 1,367 feet long, 18 feet wide, and paved with asphalt blocks (FIGURE VII-39, b).

(3) *Awaji.*

There are but 2 prefectural roads on this mountainous island. One follows the coast, and the other runs through the hills from Sumoto on the east coast to Minato on the west.

The roads are gravel, enabling trucks and automobiles to maintain an average speed of 20 to 35 miles per hour. The roads have many curves and turns which necessitate single-lane traffic in many places.

D. Southern Honshū.

The road pattern of Honshū has 2 centers, one being the Tōkyō area and the other the Kyōto-Ōsaka-Kōbe area. Two main highways link them. They are: 1, the Nakasendo (Central Mountain Road) from Tōkyō to Kyōto via Fukushima, Mitake, and Hikone, across Kiso-Sammyaku (range), and, 2, the Tōkaidō Road, roughly following the coast and linking Yokohama, Shizuoka, and Nagoya with Kyōto. Both roads join to the east of Ōtsu to form the main highway of the southern

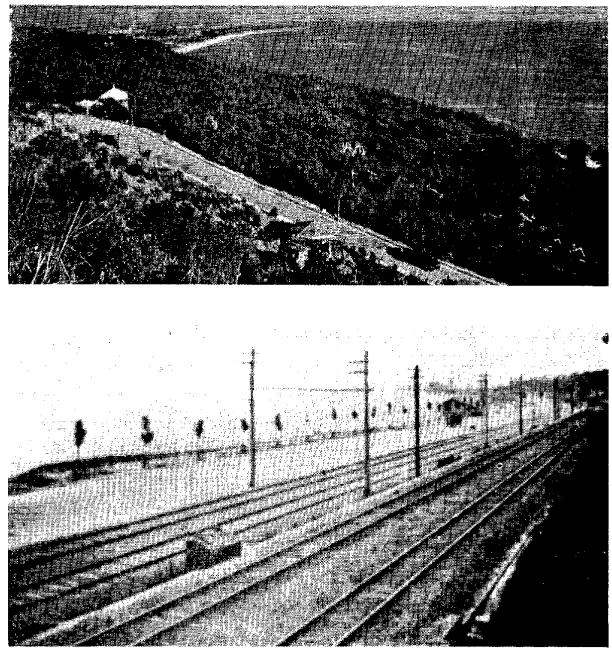

FIGURE VII-42. *West of Kōbe.*
Two views of the coastal highway.
(a) 1938.
(b) 1930.

Honshū area, that is, the excellent road linking the 3 major cities of Kyōto, Ōsaka, and Kōbe.

The Nagoya and Ōsaka plains are centers of population in southern Honshū and, as such, are the areas best served by national highways and other first-class roads (FIGURES VII-3 and VII-59). A notable feature of the pattern of main roads is the constriction south of Biwa-ko, where all national highways between northern and southern Japan follow the same route for about 25 miles from east of Ōtsu to Kyōto.

From the Kyōto-Ōsaka area, 2 main highways, both coastal for much of their length, lead to Ogori and thence along the same route to Shimonoseki (FIGURE VII-59). Two national highways cross the mountainous interior, one route extending north from the vicinity of Himeji to Tottori, and the other northwest from the same junction to the coast at Yonago.

Secondary roads are most numerous in the Nagoya and Ōsaka regions, forming an irregular pattern which shows plainly the effect of terrain (FIGURES VII-3 and VII-4). South of Ōsaka, the ruggedness of Kii-hantō (peninsula) limits even secondary roads to a coastal route and 1 main cross-peninsular route. In the western part of the island, one secondary road follows the central mountain spine; leg-like routes extend to the coast to form cross-island connections.

In general, the roads of Japan were not built for motor traffic and, even now, few of them come up to American standards. In southern Honshū, few of the highways are paved, although most through routes are gravelled. The best stretch of road in the area is the main highway from Nagoya to Kōbe and beyond, which is reported to have been paved with concrete the entire distance between these cities (FIGURE VII-42). The portion lying between Kōbe and Ōsaka is a first-class super-highway (FIGURE VII-43). Approximately 16 miles long, it has an

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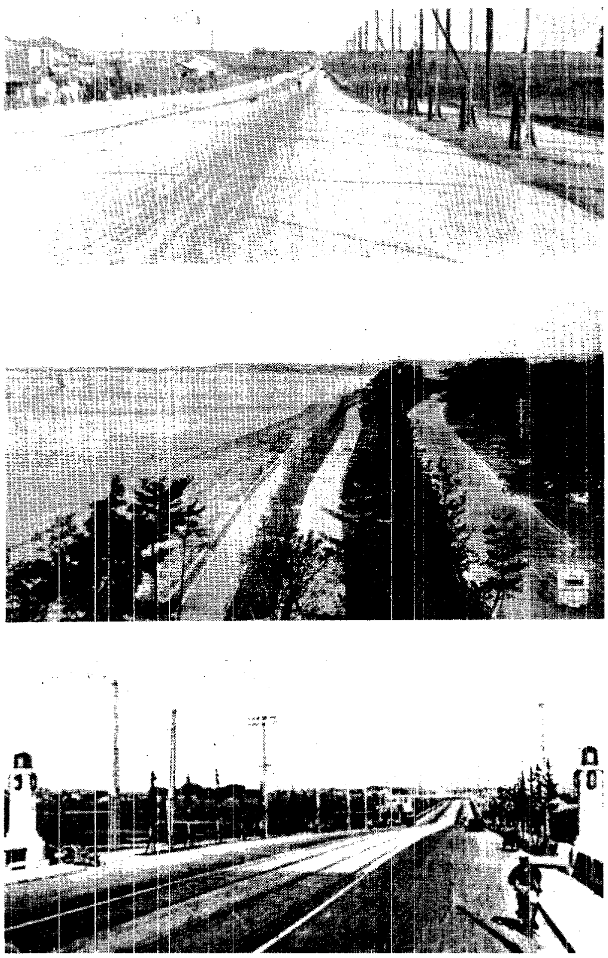

FIGURE VII - 43.
Views of the Ōsaka-Kōbe highway.
(a) Early view of the highway, near Ashiya. 1926.
(b) Suburban section at Maiko beach.
(c) Urban section. 1930.

average width of about 90 feet and is divided into 5 sections, the center being occupied by an electric railway, the outer strips by sidewalks, and the others by 24-foot driveways. Completed in 1927, it is a thoroughly modern highway, well drained, and with bridges of excellent construction. The paving consists of a 6-inch thick cement concrete base and a 2-inch thick wearing surface of bituminous concrete. The largest bridge on the highway crosses Yodo-gawa and is 2,412 feet long and 66 feet wide.

73. *Water Transport*

A. Coastal and interisland.

Coastal and interisland waterways are a vital and integral part of the Japanese transportation system. The great development of the waterways has been caused by 3 main factors: 1, the handicaps that rough terrain imposes on land transportation; 2, the irregular coastline with its many natural harbors; and, 3, the division of Japan proper into numerous islands, which makes it impossible to go to all parts of the country by overland routes.

Since 1920, Japan's merchant marine has ranked third in size among the world's marine powers. Important measures were undertaken by the Japanese government in the 1930's to scrap obsolete vessels, to construct modern ones, and to augment greatly the total carrying capacity. Despite these measures, however, Japan has been confronted with a serious bottleneck in both coastal and overseas shipping. Attempts to alleviate this situation have been made by purchasing foreign vessels, licensing the charter of foreign ships to engage in coastal trade, and routing more freight by railroad. But the shortage of ships still threatens seriously to impair Japan's military demands. An outstanding example of the effect of this lack of coastal shipping has been the necessity of periodically restricting coal consumption in the Kōbe-Ōsaka district, while coal stocks at the collieries in Kyūshū accumulated.

Coastal boats carry chiefly cargoes of coal, rice, ore, iron ingots, and similar bulk material.

(1) *Numbers and tonnages of ships.*

The Japanese Ministry of Communications made the following report at the end of November 1940 on tons of registered shipping for vessels up to 1,000-ton size:

SIZE OF SHIPS	TOTAL TONNAGE
20 - 100 tons	90,247
100 - 300 tons	110,931
300 - 500 tons	88,311
500 - 1000 tons	178,850

By July 1943, the tonnage is estimated to have been as follows (wooden ships are shown at 1/3 of their face value as they are a relatively inefficient method of marine transportation):

	TOTAL TONNAGE
Steel ships under 1,000 tons	315,000
Wooden ships large enough for commercial use	158,000

Recent attempts to increase coastal shipping have included both the construction of small wooden vessels and standard-type steel ships similar to those built in the United States.

(2) *Routes.*

Along the entire coasts of Kyūshū, Shikoku, and southwestern Honshū are several major routes with scheduled services, and many minor routes along which ships ply irregularly. Subsidized lines serving Southwest Japan had the following service in 1939:

(*a*) *Ōsaka-Kōbe-Shang-hai-Hankow.* Ten 2,000-ton vessels, which had a speed of 10 knots, made a minimum of 120 sailings per year.

(*b*) *Ōsaka-Kōbe-Moji-Amoy-Canton* (often calls at Nagoya and Yokohama). Three 2,000-ton vessels, which had a speed of 10 knots, made a minimum of 36 sailings per year.

(*c*) *Kōbe-Moji-Dairen.* Six 5,000-ton vessels, which had a speed of 15 knots, made a minimum of 168 sailings per year.

(*d*) *Nagasaki-Dairen.* Two 5,000-ton vessels, which had a speed of 20 knots, made a minimum of 90 sailings per year.

(*e*) *Yokohama-Nagoya (or Yokkaichi)-Ōsaka (or Kōbe)-Moji-Shang-hai: Shang-hai-Nagoya-Yokkaichi-Yokohama.* Three vessels made a minimum of 60 sailings per year.

(*f*) *Kōbe-Moji-Tientsin (or Tangku).* Four 1,500-ton vessels, which had a speed of 12 knots, made a minimum of 100 sailings per year.

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(*g*) *Yokohama-Nagoya-Osaka* (*or Kōbe*)*-Dairen-Tientsin* (*or Tangku*). One 1,500-ton vessel, which had a speed of 10 knots, made a minimum of 30 sailings per year.

(*h*) *Kōbe - Moji - Tsingtao*: *Tsingtao - Moji - Hiroshima-Kōbe.* Four 3,000-ton vessels, which had a speed of 13 knots, made a minimum of 100 sailings per year.

(*i*) *Tsuruga-Seishin-Rashin-Vladivostok.* One 4,000-ton vessel, which had a speed of 16 knots, made a minimum of 36 sailings per year.

(*j*) *Tsuruga-Seishin-Rashin.* One 5,000-ton vessel, which had a speed of 15 knots, made a minimum of 36 sailings per year.

(*k*) *Kagoshima-Nase-Naha.* Two 1,200-ton vessels, which had a speed of 12 knots, made a minimum of 104 sailings per year.

(*l*) *Ōsaka-Kōbe-Nase-Naha.* Two 4,000-ton vessels, which had a speed of 15 knots, made a minimum of 54 sailings per year.

The Inland Sea is the most important of Japan's waterways. The many routes which crisscross it produce a particularly intricate pattern, and in most cases constitute the only means of access to its many islands. A motley group of vessels of all types, ranging from junks to passenger liners and including fishing craft, lighters, tugboats, service vessels, naval craft, and coastal luggers, ply its waters (FIGURES VII - 44 and VII - 45).

(3) ***Ports of call.***

Kyūshū, Shikoku, and southwest Honshū have a relatively large number of ports of call for coastal and interisland steamers (FIGURE VII - 59; CHAPTER VI). Among the more important are the following:

(*a*) *Kōbe.* Kōbe is the leading port of Japan. Much coal is brought in from the southwest through the Inland Sea, most of it hauled in barges of 200- to 500-ton capacity, towed by powerful tugboats. Large shipments of pig iron are also received at Kōbe. Before the war, this port had important steamer connections with American, European, and Australian ports. In addition, steamers made daily runs to Yokohama, and less frequently to other Japanese ports, and to various ones in Korea and China. Less shipping has been seen in Kōbe, however, since the outbreak of the war.

(*b*) *Ōsaka.* In 1939, the port of Ōsaka handled 26.9% (by value) of Japan's exports. It is the chief port of trade with Asia, and receives large shipments of cotton and pig iron. Constant dredging is maintained so that large ships can berth here.

(*c*) *Nagoya.* Nagoya can berth 66 ships ranging up to 20,000 tons. Japanese (and, formerly, foreign) vessels called here frequently.

(*d*) *Moji.* Moji is an important ferry terminal for the government railways, and maintains important coastal and overseas steamer connection. It is one of Japan's principal ports of embarkation for troops and military supplies.

(*e*) *Shimonoseki.* Shimonoseki is an important ferry terminal for the government railways, and maintains important coastal and overseas steamer connection. It, too, is one of Japan's principal ports of embarkation for troops and military supplies.

(*f*) *Nagasaki.* Nagasaki is a port of call for some of the principal steamship lines and can accommodate deep-draft vessels.

(*g*) *Yokkaichi.* Yokkaichi has daily steamer connection with Matsuzaka, Tsu, and Atsuta in the Ise Kai, and steamer service to Yokohama.

(*h*) *Wakamatsu.* Wakamatsu is one of the most important ports for the importation of iron ore.

(*i*) *Tsuruga.* Tsuruga is one of the embarkation ports for troops and military supplies bound for northern Korea and Manchuria. Commercial steamers connect Tsuruga with ports on the Asiatic mainland and with other ports in Honshū.

(*j*) *Ube.* A considerable amount of coal is shipped out of the port of Ube. A quay in this port has depths of 18 feet alongside.

(*k*) *Kagoshima.* Steamers plied from Kagoshima to Nagasaki and Kōbe.

(*l*) *Miike.* Large bituminous coal fields lie adjacent to Miike, and the port is a busy coal shipping center.

(*m*) *Karatsu.* The port of Karatsu is small, but has importance as a coal shipping port. Coal is transferred to ships by means of lighters.

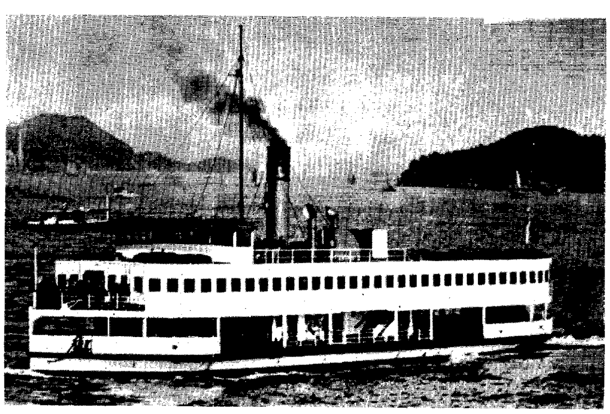

FIGURE VII - 44. *Inland Sea, near Moji.*
Traffic on the Inland Sea. Before 1935. Passenger ferry in foreground.

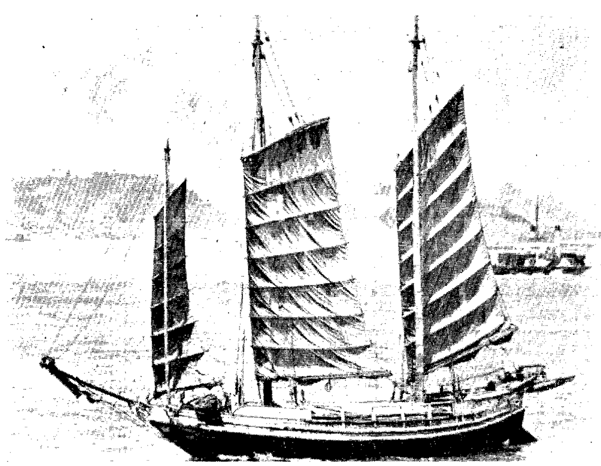

FIGURE VII - 45. *Inland Sea.*
Traffic on the Inland Sea. About 1935. Japanese sailing vessel in foreground.

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(*n*) *Kure.* One of the largest naval bases in Japan is at Kure.

(*o*) *Hiroshima (port of Ujina).* This port accommodates small steamers up to 5,000 tons. The Inland Sea Lines of *Nippon Yusen Kaisha* and *Kawasaki Kisen Kaisha* make regular stops here.

(*p*) *Fukuoka and Hakata.* Almost daily steamer connection was maintained between the ports of Fukuoka and Hakata and the ports on the Inland Sea and Nagasaki.

(*q*) *Maizuru and Miyazu.* Small steamers made several runs daily between Maizuru and Miyazu. Other coastal steamers call occasionally at Miyazu. One of the minor bases for the Japanese fleet is at Maizuru.

B. Ferries.

Ferries link the parts of Southwest Japan's interisland railway system and move passengers and goods across several important coastal waterways. Sixty-two steamers, owned by the Imperial Government Railways, were engaged in ferry service during 1937. These steamers, which had an aggregate of 62,048 tons, carried 8,582,960 passengers and 6,114,216 metric tons of freight in Japan during that year. In addition to the Imperial Government Railway ferries, there are several small ferry services.

(1) *Railway ferries.*

Southwest Japan has 2 railway ferry lines. One connects the port of Shimonoseki in southwestern Honshū to the port of Moji in northern Kyūshū. The other line, whose terminals are Tamano and Takamatsu, links the railway networks of Honshū and Shikoku.

(*a*) *Shimonoseki-Moji.* Five railway ferries were operated on this line; each of them carried 7 to 10 coaches or box-cars at one time. It is probable, however, that this ferry service has either been eliminated or greatly curtailed as a result of the construction of a railway tunnel across the strait. According to a Japanese radio broadcast of 8 August, 1943, it required 3 hours' time to transfer railway rolling stock across the strait by ferry. The same broadcast stated that the crossing time had been reduced to 20 minutes through use of the tunnel.

(*b*) *Tamano-Takamatsu.* These terminals are 11 miles apart, and railway rolling stock is moved on barges equipped with railway tracks. The barges are towed by tugboats (FIGURE VII - 46).

(*c*) *Hakata-Fusan.* A new ferry service was to have been opened between Hakata and Fusan in 1943. It was apparently intended to be a railway ferry, joining the Korean railway system to that of Japan proper.

The railway ferries are an especially vulnerable target. As Japan proper consists of several islands, any disruption of the railway ferry service would seriously cripple Japan's transportation system.

(2) *Passenger and goods ferries.*

One passenger and goods ferry connects Tsuruga and Niigata, the chief ports on the northwestern coast of Honshū, which also have ferry service to the Korean ports of Seishin and Rashin. This service has been greatly developed in the past few years, and information regarding the type of service and number of ships has been withheld. Another line goes from Shimonoseki to Dairen (122 nautical miles). Three ferries on this line are engaged in passenger service and 3 in freight movement. The passenger ships are exceptionally fine. Two

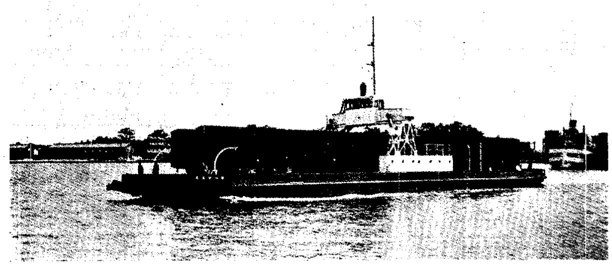

FIGURE VII - 46. *Inland Sea.*
The Tamano-Takamatsu railroad ferry between Shikoku and Honshū.

of them, the *Kongo Maru* (FIGURE VII - 47) and the *Kana Maru,* are about 7 years old, very fast, and of 7,000-ton size. The freight service is especially important because of the large amount of coal that is transported for use by the Japanese railways. There is also a passenger and goods ferry service between Moji and Shimonoseki. Another line is reported to link Shimonoseki and Fusan. Before the war, a ferry linked Awaji to Honshū, the terminals being the towns of Iwaya and Akashi station. This line is presumably still in operation.

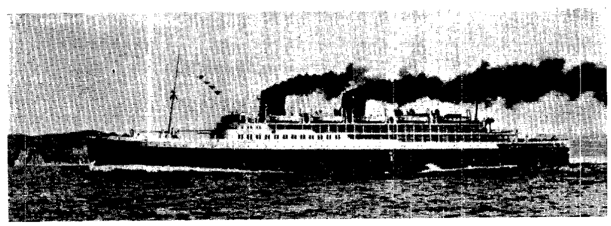

FIGURE VII - 47. *Shimonoseki vicinity.*
The ferryboat Kongo Maru, on the Shimonoseki-Dairen line.

C. Inland.

Transportation on the inland waterways of Southwest Japan is relatively unimportant. Few rivers are navigable even by shallow-draft boats (TABLE VII - 8), and little freight is transported on the canals.

(1) *Rivers.*

Most of the streams are short, swift, shallow, frequently interrupted by rapids, and generally unfit for navigation except near the mouths. Hydro-electric developments obstruct some stream channels; others, which have much of their volume diverted for irrigation, are shallow even in their lower courses. Moreover, since most streams carry large quantities of silt, large bar formations commonly occur at the mouths. These bars can be crossed only by shallow-draft vessels, and constant dredging is required to keep their channels open. Moreover, the approaches to the mouths of Chikugo-gawa and several other rivers, which empty into bays, are almost entirely blocked by extensive mud flats. Flooding is another serious problem, and frequently causes considerable damage.

River improvement works have been constructed on several

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TABLE VII - 8.
NAVIGABLE RIVERS OF SOUTHWESTERN JAPAN.

NAME	LOCATION	MOUTH	NAVIGABILITY	REMARKS
S. W. Honshu				
Asahi-gawa	Empties into NW part of Harima-nada (bay) about 4 mi. SE of Okayama.		Boats ascend from Okayama port to Okayama (about 4 mi.).	
Yodo-gawa	Empties at Ōsaka.		Navigable about 52 mi. for small vessels. Boats can go from Yodo-gawa to Biwa-ko via Biwa Canal.	Several regulating sluices have been constructed and dredging is maintained.
Kiso-gawa	Empties into Ise-wan about 12 mi SW of Nagoya.		Very shallow-draft vessels ascend about 50 mi.	Figure VII-48.
Tenryū-kawa	S coast. Empties 6 mi. SE of Hamamatsu.	Off the mouth is a semi-circular sandspit.	Small native craft ascend about 135 miles.	
Sendai-kawa	N coast. Empties about 4 mi. N of Tottori.	Channel across bar can be navigated only by small boats in calm weather. Entrance is about 100 yds. wide.	Most shallow-draft boats ascend about 20 mi.; some go approx. 40 miles.	During westerly winds, the sea breaks heavily at river entrance, especially during falling tide.
Sada-gawa	N coast. Flows E from Shinji-ko to Nakano-umi.		Steam launches can enter Nakano-umi at Sakai and proceed to Shinji-ko via Sada-gawa.	Depths in Sada-gawa are 6′ to 12′ to within 1,000 yds. of Shinji-ko. From that point on, depths are 3′ to 4′.
Gono	NW coast. Empties near Gōtsu.		Junks ascend about 15 mi.	
Takatsu-gawa	NW coast. Empties at town of Takatsu.	About 200 yds. wide.	Junks ascend about 15 mi.	
Gokase-kawa	E coast. Flows through Nobeoka and empties about 1½ mi. to the E.	The mouth is about 600′ wide. Depths in the river are shoal, and tidal streams are strong.	6½ mi. (about 5 mi. above city of Nobeoka).	
Suminoe-kawa	W Kyūshū. Empties into Shimabara-kaiwan, about 17 mi. NW of Ōmuta.	Vessels drawing 21′ reportedly enter river at high water springs. Max. draft at high water neaps is 15′.	Vessels of 3,000 tons ascend nearly 2 mi. to port of Suminoe.	Coal is exported from port of Suminoe.
Kuma-gawa	W Kyūshū. Empties into E side of Yatsushiro-kai about 20 mi. NNE of Minamata.	The river divides into 3 channels near the mouth.	The velocity of the stream is quite strong, but boats go 16 mi. upstream.	
Sendai-kawa	W coast. Empties about 7 mi. W of city of Sendai.	Boats can cross bar only during calm weather.	Small craft ascend about 40 mi.	The fishing village of Kuminsaki is on S side of river entrance.
Shikoku				
Yoshino-gawa	E coast. Empties near Tokushima.	The river divides into 4 distributaries, one of which flows through Tokushima.	Small craft ascend about 65 mi.	This is the largest stream on Shikoku. The river discharges quantities of silt and the mouths are constantly changing.

of the major streams, such as Yodo-gawa, Kiso-gawa, and Yoshino-gawa. These works are designed to aid navigation at the estuaries by preventing excessive silting, and to control flood water. The improvement works consist mainly of: 1, levees to confine the flood stream; 2, movable dams, sluices, and canals to divert some of the additional stream flow during periods of flood; 3, retarding basins to equalize stream flow; and, 4, straightened channels to quicken flood discharge. The movable dams, sluices, and canals are located near the estuaries, and, by diverting some of the flood waters, reduce silting in the river and make dredging for navigation feasible.

The river boats are small and flat-bottomed. Their average dimensions are about as follows:

Length	80 feet
Beam	11.5 feet
Draft	2.5 to 3.6 feet
Capacity	15 to 20 tons

(2) *Canals.*

There are many short canals, most of which were constructed for irrigation and drainage.

The most important canal is the Biwa Canal, which forms a part of the through route from Biwa-kō to Ōsaka. It was constructed to generate electricity, and to facilitate transportation, irrigation and fire service. The canal, which is 36,642 feet long, extends from Ōtsu to Kyōto. It has 7 dams, 3 tunnels, 2 locks, 2 sluices, and 1 inclined lift (FIGURE VII - 49). The boats on the canal are towed; at the incline, they are hauled on to 4-wheeled steel trucks by cable and electrically-operated winches. These boats have about the following maximum dimensions: length, 45 feet; beam, 6.9 feet; draft, 1.96 feet; capacity, 10 to 15 tons. The tunnels through which the canal passes are 804 feet, 395 feet, and 2,801 feet long respectively. Each tunnel is 14.1 feet high and 16.1 feet wide. The branch canal, which was completed 8 years later in 1912, was built to help meet increasing demands for water power and irrigation.

Most of the short canals are a part of the flood control works which have been built at the deltas of major streams. The network of small canals in Nagoya and Ōsaka belong in this category, although regulating dams have been constructed to make them usable by small boats. Some of the canals in irrigated districts are used to a limited extent for navigation.

The Hamamatsu Canal, 3.6 miles long and 27 feet wide, extends from the town of Hamamatsu to Hamana-ko (lagoon).

(3) *Lakes.*

Southwest Japan has numerous lakes, only two of which are noteworthy for purposes of transportation.

(*a*) *Biwa-kō* (*lake*). The largest of Japanese fresh water lakes is Biwa-ko, 7½ miles east of Kyōto. It is 36 miles long and 12 miles wide, and is joined to Kamo-gawa and Yodo-gawa by the Biwa Canal. Before the war, small boats made circuit runs at frequent intervals to the larger towns along the lake.

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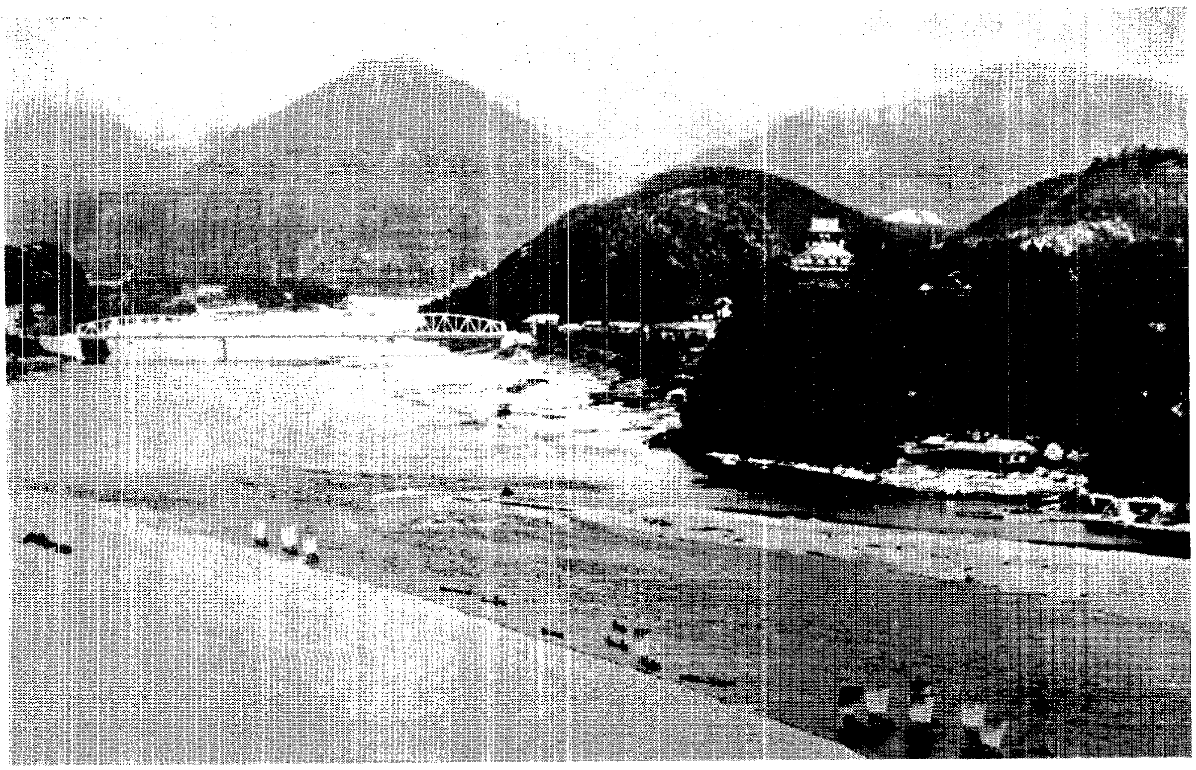

FIGURE VII - 48. *The Kiso-gawa (river) at Inuyama, Aichi prefecture.*
Small river craft in foreground. Bridge on main Nagoya-Tōkyō mountain road in background. 1932.

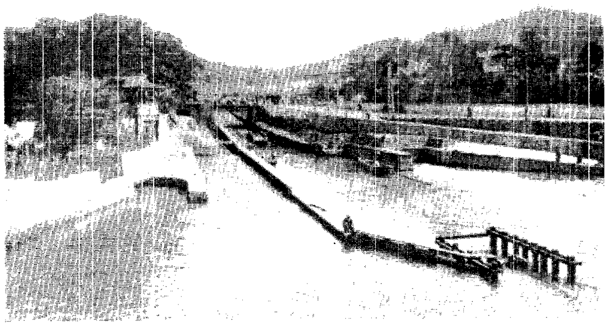

FIGURE VII - 49. *Shiga.*
Looking southward at the inclined boat lift on the Biwa Canal.

(*k*) *Shinji-ko.* This lake is located west of Matsue, near the northern coast of southwestern Honshū. It is 9 miles long, about 3 miles wide, and has depths of 3¼ to 3½ fathoms in the central portion. Small steamers navigate from the port of Sakai through the salt water Nakami lagoon to Shinji-ko via the Sada-gawa.

74. *Radio*

Japan has expanded her communications facilities tremendously during recent years, placing the greatest emphasis on radio (FIGURE VII - 57). Her carefully located network of broadcasting stations has been little changed, but equipment has been modernized in many instances, and overseas broadcasting has received more and more attention. The greatest increase has been in the equipment made available for army and navy communications. Labor and raw materials have been diverted to communications at the expense of other work of admitted importance. Radio equipment used by the Japanese military is very compact in design and of good workmanship.

A. Administration.

Domestic broadcasting, including operation of stations and production of programs, is in the hands of the Japan Broadcasting Corporation (*Nippon Hoso Kyokai*), while international radiotelegraph and radiotelephone service is handled by the International Telecommunications Company. Both these companies are completely under the control of the Transportation and Communications Ministry of the Japanese Government. Military "advisers" frequently make the actual decisions regarding types of equipment to be produced and programs to be used for propaganda purposes.

The Japan Broadcasting Corporation derives its income (more than $5,000,000 in 1939) from a monthly fee of 50 *sen* (about 12 cents U.S.) for each home receiver. The International Telecommunications Company gets its income from charges for transmitting messages.

Short-wave receivers cannot be owned legally in Japan except by special permission. Broadcasting stations are so located throughout the country that low power receivers are adequate, and a "standard" receiver, with low reception radius, has been promoted by the government. As a result, almost no Japanese-owned radio receiver is powerful enough to receive foreign broadcasts. Amateur radio stations in Japan have been under close supervision for many years.

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B. Equipment.

Japan is virtually independent of outside sources for radio equipment. Except for very recent innovations and certain highly specialized items, Japan manufactures sufficient radio equipment for the needs of Greater East Asia. Basic designs usually came from the United States or Germany, but many refinements are of Japanese invention, and workmanship is nearly equal to that of Allied nations.

(1) *Broadcasting equipment.*

Little is known of the present status of Japan's broadcasting equipment. Transmitting and receiving sets supplied by the Radio Corporation of America and Telefunken (Germany), prior to Pearl Harbor, are presumably still in operation. In addition, Japan manufactures sets of equal power (up to 150,000 watts), usually designed from imported models. Japanese supplies of specialized items, such as relay cable and radio tubes, are adequate for her known requirements.

(2) *Radio receivers.*

Nearly all radio receivers for home use are cheap (about $2), compact, of simple design, and capable of picking up at least 1 broadcasting station from any point in Japan proper (TOPIC 74, E). They are similar to the "midget" table models popular in the United States, but of inferior workmanship. The best in materials and manufacturing skill is reserved for military equipment, the materials and workmanship of which are excellent, although the design is frequently simplified so as to include only the barest of essentials. Battery sets for home use are now nearly obsolete in Japan.

C. Radiotelegraph.

Japan has always favored radiotelegraph rather than wire for long-distance communication. Furthermore, radiotelegraph has been ideally suited for keeping in touch with Japan's islands at a minimum of expense and under adverse weather conditions. This natural growth of radiotelegraph has been encouraged and stimulated by the military, who recognize it as a highly flexible method of communicating along changing battlefronts.

(1) *International circuits.*

Starting in 1927, Japan rapidly extended her overseas radiotelegraph channels to include direct circuits with most of the leading cities of North and South America, Europe, and Asia. Operation of this service is in the hands of the Japan Wireless Telegraph Company, a subsidiary of the International Telecommunications Company. Antenna power and accurate beaming are roughly comparable to those of the best transmitting stations in the world. In sending or receiving messages, automatic repeaters are used, which connect the antenna with the land line leading to one or more of the funnels for overseas messages: Tōkyō, Nagoya, and Ōsaka.

Within Southwest Japan are located the units comprising the Middle Japan Radio Central, which handles most of the radiotelegraph traffic to Europe. This Central was originally composed of a controlling station at Nagoya, a transmitting station at Yosami (Aichi) (FIGURE VII - 50), and a receiving station at Yokkaichi (Mie). An entire additional group of stations has been completed, including a controlling station at

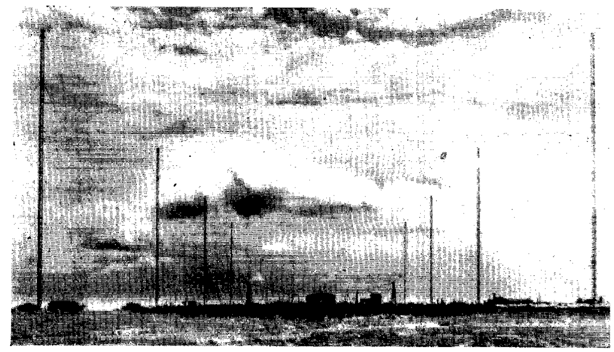

FIGURE VII - 50. *Southeast of Nagoya.*
Yosami radiotelegraph station. Overseas transmitter for the Middle Japan Radio Central. 1939.

Ōsaka, a transmitting station at Semayama (Ōsaka), and a receiving station at Ono (Hyōgo). The 2 groups of stations are connected by land line, and operations can continue without interruption if any one of the stations should become disabled. The controlling station for the Middle Japan Radio Central is now located in the Ōsaka Central Telegraph Office.

(2) *Empire circuits.*

Radiotelegraph is extensively used to keep Japan in touch with the outer portions of her empire. Service for official use and for public use is maintained between Japan and the Chishima-rettō, Korea, Manchuria, Inner Mongolia, North (Occupied) China, Formosa, conquered areas of the East Indies, and the semi-independent nations of southeast Asia.

(3) *Domestic circuits.*

Domestic radiotelegraph is not necessarily considered superior to land communication, but is used in those cases when other means of communication are not available. Some small islands off the Japanese coast and many ships at sea are forced to rely on radiotelegraph under ordinary circumstances, while circuits are kept in operation between leading cities on the main islands to supplement line communication and to handle traffic when other service is interrupted.

D. Radiotelephone.

Most of the radiotelephone equipment in Japan is used for fairly localized traffic, such as ship-to-shore and aviation radio. In addition, there are long-distance radiotelephone circuits, which are connected with the regular telephone network. This service supplements telephone submarine cables, and replaces any line telephone circuits which may temporarily be out of order.

Japan has 2 complete groups of installations for international radiotelephone service. One of these is located in Southwest Japan and is a part of the Middle Japan Radio Central. The controlling station is at Ōsaka, the transmitting station at Semayama (Ōsaka), and the receiving station at Ono (Hyōgo). Land lines connect these stations. The Middle Japan Radio Central is primarily for circuits to southeast Asia and the islands to the south of Japan proper.

In some areas not served by telephone lines, radiotelephone is used to supplement postal and telegraph services.

As early as 1936, Japan began experimenting with long-

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distance transmission of pictures. This service was opened to the public in 1940, with regular circuits connecting Tōkyō with Berlin, London, and San Francisco. Within the next year, additional circuits were opened between Ōsaka and Hsinking and between Tōkyō and Shang-hai, Taihoku, and Buenos Aires.

E. Radio broadcasting.

Japan uses radio broadcasting as a constant means of disseminating domestic propaganda, and has planned the radio network in such a way as to discourage listeners from seeking other sources of information. Home receivers are available at very low prices, and broadcasting stations are spaced evenly throughout the country (FIGURE VII - 57). Short-wave stations carry similar programs to more distant parts of the Japanese Empire, while overseas propaganda programs are planned with great care.

Programs intended for listeners in Japan proper are broadcast on medium frequencies (550-1,560 kc.) (FIGURE VII - 51). A low-power receiver can pick up at least one station from any point in Southwest Japan. Most of the broadcasting stations have only 300 or 500 watts, but those at Nagoya, Ōsaka, Hiroshima, and Kumamoto have at least 10,000 watts apiece. Reports that the Ōsaka and Kumamoto stations were being increased to 100,000 watts have not been confirmed. It is strictly forbidden to listen to short-wave broadcasts or to possess a receiver capable of picking up short-wave transmissions.

All medium-wave broadcasting stations are connected by wire with Station JOAK in Tōkyō. Any number of stations can broadcast the same program simultaneously, or programs can be initiated at the local stations.

In 1939, radio receivers totaled 4,666,000 in Japan proper and were increasing at a rate of more than half a million annually. This rate has doubtless fallen off sharply since that time, but there are probably about 5,500,000 receivers now in operation in Japan proper (TOPIC 74, B (2)). The ratio of receiving sets per capita in prefectures which are predominantly urban is as much as twice the ratio in rural prefectures.

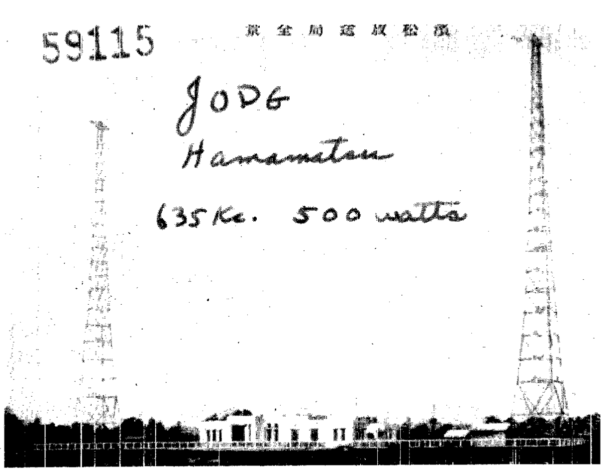

FIGURE VII - 51. *Shizuoka prefecture.*
Hamamatsu broadcasting station. Typical low-power, medium-wave transmitter.

F. Radio stations.

Radio installations in Southwest Japan are listed in TABLE VII - 9. Information is believed to be accurate up to 1940, with some data from more recent sources. No attempt has been made in this chapter to cover thoroughly radar installations or radio installations used exclusively for contact with planes.

TABLE VII - 9.
RADIO STATIONS IN SOUTHWEST JAPAN.
(Arranged alphabetically by prefecture)

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Aichi					
Morozaki	34 42 N 136 58 E	JQD			Unidentified.
Nagoya	35 03 04 N 136 58 02 E	JOCK	730 990	10,000 10,000	Medium-wave broadcasting station.
Nagoya	35 08 N 136 55 E				Alternative control station for Middle Japan Radio Central. Land wire to Yosami Transmitter, Yokkaichi (Mie) receiver, and Ōsaka studios.
Nagoya	35 05 19 N 136 53 07 E	JHY	454 500	100	Ship-to-shore radiotelegraph.
Shino Shima	34 40 15 N 137 00 10 E	JQE			Unidentified.
Yosami	34 58 15 N 137 01 18 E	JAF	13,400	10,000	Radio telegraph transmitter for Middle Japan Radio Central. Receiver is at Yokkaichi (Mie) control stations at Nagoya and Ōsaka. (Figure VII - 50).
		JAG	17,840	10,000	
		JAG	17,885	10,000	
		JAI	9,215	10,000	
		JAJ	15,840	10,000	
		JAK	6,700	1,000	
		JAL	8,920	1,000	
		JAM	14,840	1,000	
		JAO	9,782.5	20,000	
		JAQ	8,050	20.000	
		JAQ2	8,055	20,000	
		JAS	18,360	20,000	
		JAW	17,400	20,000	
		JET2	18,365	40,000	
		JEN2	19,045	20,000	
		JNA	8,980	20,000	
		JNB	13,880		
		JNB2	13,875	20,000	
		JNC	17,960	20.000	
		JNC2	18,005	20,000	
		JND	17.44	50,000	
		JNE	10,160	5,000	
		JNF	15,720	5,000	
		JNG	19,120	5,000	
		JNH	7,820	5,000	
		JNH2	7,815	20,000	
		JNI	12,200	5,000	
		JNJ	13,945	20,000	
		JNJ2	13,940	20,000	
		JNK2	14,975	1,000	
		JNL	6,810	10,000	
		JNM	5,980	10,000	
		JNN	19,000	5,000	
		JNQ	15,790	20,000	
		JNS	5,100	40,000	
		JNS2	7,980	35,000	
		JNS3	10,925	30,000	
		JNS4	14,970	25,000	
		JNS5	18,445	20,000	
		JNT	18,355	40,000	
		JUA	5,770	10,000	
		JUC	4,900	10,000	
		JUC2	5,827.5	10,000	
		JUG	6,790	20,000	
		JUH	11,520	20,000	
		JUK	9,025	1,000	
		JUK	11,915	1,000	
		JUK	12,037.5	1,000	
		JUS	12,010	1,000	

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TABLE VII - 9 (Continued).

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Ehime					
Hahajima, Okino-shima	32 44 N 132 34 E	JQU			Unidentified.
Kashiwa-jima	32 46 N 132 37 30 E	JETA			Unidentified.
Matsuyama	33 50 N 132 46 E	JOVG	950	500	Broadcasting station.
Matsuyama	33 50 N 132 45 E				Meteorological station.
Fukui					
Fukui	36 03 50 N 136 13 23 E	JOFG	1020	300	Broadcasting station.
Fukui	36 05 N 136 12 E				Radiotelephone service reported.
Fukui	36 03 N 136 16 E				Meteorological station.
Wakasa	35 36 05 N 135 55 24 E	JWA	95 143 403 500	1,000 2,000	Ship-to-shore radiotelegraph. Radio beacon on request.
Fukuoka					
Fukuoka	33 55 10 N 130 24 00 E	JOLK	910	500	Broadcasting station.
Fukuoka	33 42 35 N 130 26 36 E	JXF	200 220 328 333 500 5,460 6,600 9,380	2,000 500 500 500 500 500 500 500	Land-to-plane radiotelegraph and radiotelephone. Power supply is same as that to Fukuoka city.
Fukuoka	33 42 37 N 130 26 17 E	JIZ JIZ-2	8,710 13,580	2,000 2,000	Radiotelegraph.
Hakata	33 41 N 130 24 E				Naval aviation radio. Meteorological station.
Kokura	33 52 59 N 130 51 41 E	JOSK	740	1,000	Broadcasting station.
Moji	33 56 48 N 130 58 08 E		276		Ship-to-shore radiotelephone. Radio masts at post office.
Gifu					
No known radio installations.					
Hiroshima					
Hiroshima	34 26 N 132 28 20 E	JOFK	830	10,000	Broadcasting station.
Hiroshima	34 23 30 N 132 27 15 E	JHL	4,110 5,160 8,120	500	Radiotelegraph.
Kure	34 15 N 132 33 E				Navy radio.
Onomichi	34 24 N 133 12 E	JODP	860	300	Broadcasting station.
Hyogo					
Amagasaki	34 42 30 N 135 25 30 E				Radiotelephone service reported .
Kōbe	34 40 16 N 135 10 11 E	JKO	4,152.5 6,810 8,325 12,620	500	Official radiotelephone for ship-to-shore service.
Kōbe	34 41 N 135 04 E	JGD	454 500	100	Official radiotelegraph.
Kōbe	34 41 N 135 11 E	JTJ	75 500	3,000 250	Marine weather observatory. Radiotelephone reported.
Kōbe	34 41 N 135 11 E				Meteorological station.
Nada, Awaji	34 12 N 134 48 E	JQR			Unidentified.
Nu-shima	34 10 N 134 49 E	JQS			Radiotelegraph.

TABLE VII - 9 (Continued).

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Ono	34 50 N 134 56 E				Radiotelegraph and radiotelephone receiving station for the Middle Japan Radio Central. Transmitter is at Semayama (Ōsaka); control station at Ōsaka.
Kagawa					
No known radio installations.					
Kagoshima					
Kagoshima	31 34 11 N 130 33 51 E	JOHG	1,050	500	Broadcasting station.
Kagoshima	32 38 15 N 130 34 25 E	JKI-2 JKI-3 JKI-4	4,055 9,055 12,105	500 500	Radiotelephone.
Kagoshima	31 38 15 N 130 34 25 E	JKB	133 143 435	1,000	Ship-to-shore radiotelegraph.
Kagoshima	31 38 15 N 130 34 25 E	JKB	260 333 500	1,500 1,500 1,500	Land-to-plane radiotelegraph.
Kagoshima	31 38 15 N 130 34 25 E	JKF JKG	99 103	1,000 1,000	Radiotelegraph. Range 1,000 miles.
Kagoshima	31 38 15 N 130 34 25 E	JKA JKC JKD JKE JKH	4,260 7,450 9,180 9,960 3,800	500 500 500 500 500	Radiotelegraph.
Kagoshima	31 35 N 130 33 E	Ka			Meteorological station.
Kusakaki-shima	30 51 N 129 28 E		300		Experimental radio beacon.
Makurazaki	31 16 N 130 18 E				Unidentified.
Me-shima	31 59 35 N 128 21 20 E	JGI	300	250	Experimental radio beacon.
Kochi					
Kochi	33 33 59 N 133 32 16 E	JORK	720	500	Broadcasting station.
Kochi	33 29 29 N 133 33 20 E	JXN	4,535 6,593 6,975 9,185	500 500 500 500	Land-to-plane radiotelegraph and radiotelephone.
Kochi	33 33 N 133 32 E	Ki			Meteorological station.
Muroto-zaki	33 15 N 134 11 E	Mu			Meteorological station.
Shimizu	32 47 N 132 56 30 E	Sd			Meteorological station.
Kumamoto					
Goshonoura-jima	32 20 15 N 130 20 10 E	JQJ			Unidentified.
Iwa (Zōzō)	32 34 N	JQM			Unidentified.
Kumamoto	32 50 12 N 130 43 16 E	JOGK	790	10,000	Broadcasting station.
Me-shima	31 59 35 N 128 21 20 E	JGI	185	250	Radiotelegraph.
Miyata	32 14 N 130 15 E	JQI			Unidentified. Location doubtful.
Noboritate	32 35 30 N 130 26 00 E	JQK			Unidentified.
Kyoto					
Kyoto	35 00 50 N 135 44 57 E	JOOK	1,070	300	Broadcasting stations.
Maizuru	35 30 45 N 135 18 30 E	JMZ	300 600 900 3,500	5,000 5,000 5,000 5,000	Naval radio. Open to public.
Miyazu	35 32 N 135 12 E				Meteorological station.
Mie					
Anori-saki	34 21 45 N 136 54 45 E				Radiotelegraph reported at lighthouse.

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TABLE VII-9 (Continued).

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Kameyama	34 51 40 N 136 27 25 E	JXK	200 215 333	500 500 500	Land-to-plane radio-telegraph and radio-telephone.
Kami-jima	34 33 N 136 59 E	JQB			Unidentified.
Toba	34 29 N 136 50 30 E	JQA			Unidentified.
Toshi	34 31 36 N 136 54 18 E	JQC			Unidentified.
Yokkaichi	34 58 15 N 136 37 25 E	JNZ	93.5	500	Radiotelegraph.
Yokkaichi	34 58 15 N 136 37 25 E				Radiotelegraph receiving station for the Middle Japan Radio Central. Transmitter is at Yosami (Aichi), control stations at Nagoya and Ōsaka.
Miyazaki					
Miyazaki	31 54 34 N 131 24 53 E	JOMG	600	500	Broadcasting station.
Miyazaki	31 55 N 131 26 E	Mz			Meteorological station.
Nagasaki					
Fukae	32 41 10 N 128 50 30 E	JECA			Unidentified.
Hisagan-jima, Gotō-rettō	33 42 N 129 52 E	JQH			Unidentified.
Isuhara, Tsushima	34 12 10 N 129 17 30 E	JXI	200 235 333 500	500 500 500 500	Land-to-plane radiotelegraph and radiotelephone.
Izuhara, Tsushima	34 12 N 129 18 E	Iz			Meteorological station.
Moji (?)		JOS	139	3,000	Ship-to-shore radiotelegraph.
Nagasaki (Aino)	32 48 05 N 130 09 25 E	JOS	95	3,000	Radiotelegraph.
Nagasaki (Aino)	32 48 05 N 130 09 25 E	JOR	5,380 8,740 12,700 17,320	1,000	Ship-to-shore radiotelegraph.
Nagasaki (Isahaya)	32 50 N 130 02 E				Receiving and re-dispatching station.
Nagasaki	32 45 N 129 53 E	JOAG	930	500	Broadcasting station.
Nagasaki	32 43 45 N 129 51 50 E	Ng			Meteorological station.
Naru-shima, Gotō-rettō	32 51 N 128 56 E	JQG			Unidentified.
Sasebo	33 09 N 129 42 E	JMG			Naval radio.
Tomie, Fukae-shima	32 36 24 N 128 45 05 E	JXF	225	500	Radiotelegraph. Replaces station at Osesaki, Fukae-shima.
Tomie, Fukae-shima	32 36 24 N 128 45 50 E	JXY	200 225 333 500	500 500 500 500	Land-to-plane radiotelegraph and radiotelephone.
Tomie, Fukae-shima	32 37 N 128 46 E	Tm			Meteorological station.
Yu-shima	32 36 N 130 20 E	JQL			Unidentified.
Nara					
Nara	34 41 N 135 50 E				Radiotelephone reported.
Ōita					
Ōita	33 14 10 N 131 40 30 E	JOIP	700	500	Broadcasting station.
Ōita	33 14 05 N 131 40 18 E	JIT	143 146 391 500	2,000	Ship-to-shore radiotelegraph. Radio beacon on request.

TABLE VII-9 (Continued).

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Ōita	33 14 10 N 131 40 30 E	JIT	95	1,000	Radiotelegraph.
Saeki	32 58 N 131 52 E				Naval air station. Radio direction finder.
Okayama					
Okayama	34 38 46 N 133 56 26 E	JOKK	630	500	Broadcasting station.
Shimotsui	34 26 16 N 133 48 33 E	JSX	109 143 433 500	1,000	Ship-to-shore radiotelegraph. Radio beacon on request.
Ōsaka					
Ōsaka (Hirano)	34 37 30 N 135 32 30 E	JNY	1,750	50	Radiotelegraph.
Ōsaka (Hirano)	34 37 30 N 135 32 30 E	JNZ-2	4,045	100	Radiotelephone.
Ōsaka	34 46 21 N 135 31 58 E	JOBK	690 940	10,000 10,000	Broadcasting station.
Ōsaka	34 31 30 N 135 31 E	JEN JEO JEP JEQ JER JES JET JEU JEV JEW JEX	4,705 13,140 11,665 10,875 8,550 4,705 4,865 5,105 6,087 9,295 12,070	2,000 2,000 2,000 2,000 2,000 2,000 2,000 2,000 2,000 2,000 2,000	Official radio-telegraph. Uses several other frequencies between 31.2 kc. and 16,240 kc.
Semayama	34 37 28 N 135 32 45 E	JEA JXO JEB JEC JED JEE JCF JEF JEG JEM JEI JGF2 JEJ JGF3 JEK JEL JGF4 JGF5 JJX JJX2 JJX3	97 240 4,480 4,610 5,680 7,310 7,780 8,020 8,960 9,755 10,120 10,840 11,560 13,480 13,510 14,660 15,535 19,040 24,130 27,030 30,030	1,000 1,000 2,000 1,000 4,000 1,000 5,000 4,000 1,000 1,000 2,000 5,000 4,000 5,000 1,000 2,000 5,000 5,000 10,000 10,000 10,000	Radiotelegraph and radiotelephone transmitter for the Middle Japan Radio Central. Receiving station is at Ono (Hyōgo); control station at Ōsaka.
Settsu	34 31 45 N 135 31 03 E	JXO	200 240 333	1,000 1,000 1,000	Land-to-plane radiotelegraph. Near Sakai.
Settsu	34 31 45 N 135 31 03 E	JXC	5,342.5 6,593 6,976 8,595 9,105	1,000 1,000 1,000 1,000 1,000	Land-to-plane radio-telegraph and radio-telephone. Near Sakai.
Saga					
No known radio installations.					
Shimane					
Matsue	35 27 06 N 133 03 33 E	JOTK	670	500	Broadcasting station.
Hamada	34 54 N 132 04 E				Meteorological station.
Sakai	35 33 N 133 14 E	SK			Meteorological station.
Shizuoka					
Hamamatsu	34 42 43 N 137 46 14 E	JODG	1,100	500	Broadcasting station (Figure VII-51).
Tokushima					
Tokushima	34 04 30 N 134 33 20 E	JOXK	980	500	Broadcasting station.
Tottori					
Tottori	35 29 40 N 134 14 08 E	JOLG	890	500	Broadcasting station.

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TABLE VII - 9 (Continued).

STATION	COÖRDINATES (in degrees, minutes, and seconds). ° ′ ″	CALL	FREQUENCY (in kc.)	WATTS	REMARKS
Yonago	35 26 56 N 133 21 04 E	JXW	5,385 6,593 6,975 9,167.5	1,000 1,000 1,000 1,000	Land-to-plane radiotelegraph and radiotelephone.
Wakayama					
Shiono-misaki	33 25 57 N 135 45 46 E	JSM	97.5 143 149 397 500	1,000	Ship-to-shore radiotelegraph. Radio beacon on request.
Shiono-misaki	33 26 N 135 46 E				Meteorological station.
Yamaguchi					
Bofu	34 03 N 131 35 E	JOUG	860	500	Broadcasting station.
Shimonoseki	33 57 09 N 130 56 27 E				Meterological station.
Tsuno-shima	34 20 30 N 130 50 30 E	JTS	90.5	1,000	Radiotelegraph. Near lighthouse.
Tsuno-shima	34 20 35 N 130 50 39 E	JTS	134 143 415 500	1,000	Ship-to-shore radiotelegraph.

75. *Land Telegraph*

The Japanese land telegraph network is built around a few key cities, with an effective funneling of messages through 7 administrative centers. For several years, the system has been operating above its efficient capacity, and, since Pearl Harbor, drastic steps have been taken to reduce telegraph traffic to an absolute minimum. More than 77,000,000 telegrams were sent in 1939, a ratio per capita second only to that of the United States.

A. Administration.

Control over equipment and operations of the land telegraph network is held by the Ministry of Transportation and Communications.

For administrative purposes, Japan proper is divided into 7 telegraph zones, 4 of which are in Southwest Japan. All telegrams originating or terminating within a telegraph zone are routed through the bureau responsible for that zone. Telegraph bureaus in Southwest Japan are located at Nagoya, Ōsaka, Hiroshima, and Kumamoto. All telegrams are subject to rigid censorship.

B. Network.

Telegraph routes run parallel to railroads, and public telegraph service is available at most railroad stations. This holds true for through service as well as local service. In addition, there are numerous short lines to points within or near cities, and a few long-distance telegraph lines follow entirely independent routes (TABLE VII - 10).

All important cities and towns are connected by telegraph, and important routes are provided with alternative lines. Weak links in the network are found in southern Kyūshū, in southern Shikoku, and along the shore of the Japan Sea. Vulnerable points occur where many lines come together, as along the northern shore of the Inland Sea, at important cable landings (FIGURE VII - 57), and where specialized equipment is located, as at the message funnels of Nagoya, Ōsaka, Hiroshima, and Kumamoto, and at other repeater stations.

TABLE VII - 10.
JAPANESE LAND TELEGRAPH LINES (1939).

	ROUTE MILEAGE	WIRE MILEAGE
Aerial lines	30,439	140,594
Overhead cable	88	17,667
Underground lines	490	61,926
Total	31,017	220,187

The largest cities have offices devoted solely to telegraph service. In most communities, however, telegraph facilities are located at post offices or railroad stations. Such combination offices are particularly strategic, as they usually contain telephone facilities as well (TABLE VII - 11).

TABLE VII - 11.
JAPANESE TELEGRAPH OFFICES (1939).

First-class	8
Second-class	47
Postal and telegraph offices	10,745
Minor offices	2,425
Total	13,225

Japan is independent of foreign supplies of telegraph equipment and wire. Specialized apparatus, such as teletypewriters, printers, and automatic repeaters, is adequate in design, but not available in sufficient quantity (TABLE VII - 12). As she has done with her other communications facilities, Japan has provided poor maintenance for her telegraph system (TABLE VII-13).

TABLE VII - 12.
TELEGRAPH APPARATUS IN JAPAN (1938).

Telephones for telegraphic service	8,622
Ink writers	2
Senders	5,918
Automatic telegraphs, duplex	178
Undulator and siphon recorders	17
Printing telegraphs duplex	84
Phototelegraphs	5
Telegraph repeaters	183
Portable telegraphs	24
Automatic telegraph repeaters	2
Simple exchange machines	2
Total	15,037

NOTE: The total number of telegraph apparatus had increased to 15,893 by 31 March 1939.

TABLE VII - 13.
FAULTS ON JAPANESE LAND TELEGRAPH LINES.
(Year ending 31 March 1938).

TYPE OF FAULT	NUMBER OF OCCURRENCES	TIME LOST IN HOURS
Crosses	3,990	18,392
Grounds	3,859	20,184
Opens	3,273	11,385
Leakage	382	4,040
Others	1,480	2,191
Total	12,984	56,192

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76. *Telephone*

A. General.

Japan's telephone system has good equipment, but the quantity available has been notoriously inadequate for many years. Automatic exchanges are the rule in large cities and through circuits connect important cities in Japan with cities elsewhere in the Japanese Empire (TABLE VII - 14).

TABLE VII - 14.
LAND TELEPHONE LINES IN JAPAN (1939).

	MILEAGE	
	ROUTE	WIRE
Aerial lines	39,022	390,599
Overhead cables	6,884	1,332,828
Underground cables	3,127	2,997,617
Total	49,033	4,721,044

In all cities except the very largest, the telephone exchange is located in one building with the post office and the telegraph office (TABLES VII - 15 and VII - 16).

TABLE VII - 15.
TELEPHONE EXCHANGES IN JAPAN.

	1937	1939
First-class telephone offices	9	12
Branch offices	46	63
Second-class telephone offices	3	5
Telephone and telegraph offices	69	54
Post offices	5,269	6,063
	5,396	6,197

TABLE VII - 16.
TELEPHONE STATIONS IN JAPAN.

	1937	1939
Stations in post offices	8,474	10,739
Stations in telegraph offices	13	
Telephone and telegraph stations	96	54
Telephone stations in mines	250	335
Subscribers' telephones	914,320	1,006,498
	923,153*	1,017,626

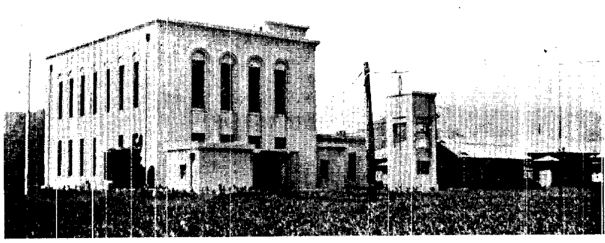

FIGURE VII - 52. *Ejiri, Kyōto prefecture.*
Telephone repeater station.

Repeater stations (FIGURE VII - 52) and intermediate exchanges are highly vulnerable points on all long-distance circuits.

*The annual report of the Communications Ministry, from which these figures are taken, gives a total of 1,003,045 telephone instruments. The above figures do not include telephones which are believed to be installed in each of the 1,206 police stations, 4,757 police boxes, and 14,182 police substations.

The Japanese public has a passion for owning and using the telephone. More than 5,000,000,000 calls were placed in 1939, and many persons have waited as much as 15 years to obtain one of the few telephones released to the public. Little progress has been made in expanding service to rural areas, and almost all the new telephones installed in the past 5 years have gone to industrial centers.

The telephone system, like other communications services in Japan, has suffered from poor maintenance. Faults average nearly two per year for each telephone instrument in use (TABLES VII - 17 and VII - 18).

TABLES VII - 17.
FAULTS ON URBAN TELEPHONE LINES IN JAPAN.

LOCATION OF FAULT	YEAR ENDING 31 MARCH 1937	1938
Exchange offices	518,214	724,350
On routes	368,937	363,884
Subscribers' stations	654,324	636,964
Total	1,541,476	1,725,198

TABLES VII - 18.
FAULTS ON
SUBURBAN TELEPHONE LINES IN JAPAN (1937).

TYPE OF FAULT	NUMBER OF OCCURRENCES	LOSS IN HOURS
Crosses	6,342	29,298
Grounds	5,283	24,021
Opens	6,013	20,092
Leakage	9	29
Others	1,300	3,421
Total	18,947	76,861

B. Administration.

Control of Japan's telephone system falls directly under the Transportation and Communications Ministry. For administrative purposes, the country is divided into 7 telephone districts; the 4 districts within Southwest Japan have their main offices in the communications centers of Nagoya, Ōsaka, Hiroshima, and Kumamoto.

Telephone service has had to compete with radio and other communications work for trained personnel. The total number of non-military telephone workers is probably smaller now than it was 5 years ago, and women have replaced men wherever possible.

C. Telephone exchanges and circuits.

All messages must pass through a local exchange. Long-distance calls must also be funneled through the district cental, then go to the central of the receiving district, and finally must pass through the local exchange of the person called. Because of this funneling of messages, long-distance circuits are particularly vulnerable at exchanges, and the expansion of the system is limited by the capacity of these installations.

Following the great earthquake of 1923, replacement buildings were designed to absorb future tremors, making them relatively secure against bombing. At the same time, most of the new exchanges were designed for automatic rather than manual operation. Materials and equipment in the exchanges are protected against Japan's high humidity by air conditioning apparatus.

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Long-distance lines run to all prefectural capitals and industrial areas; and key cities, such as Ōsaka, Nagoya, Kōbe, Shimonoseki, Fukuoka, and Nagasaki, are connected with each other by through circuits. Service is also available to cities throughout Japanese occupied territory via radiotelephone and submarine cable (Topics 74, D and 77, C).

Both local and long-distance circuits usually follow main highways, which in turn usually follow railways. Many lines cross rivers on railway or highway bridges (FIGURE VII - 53), use aerial or submarine cable, or are even provided with special bridges (FIGURES VII - 54 and VII - 55).

Large firms have installed their own inter-city and local circuits, but these have all been taken over by the Government, with the possible exception of certain press lines. For some years, press lines between Fukuoka and Tōkyō have been carrying wirephotos, and similar service has recently been inaugurated to the mainland via submarine cable. It is believed that special exchanges are maintained by various police units, and also by radio networks, to keep central studios in touch with transmitting stations.

D. Telephone instruments.

Between 1930 and 1940, Japan's telephone expansion was not nearly equal to the demand. In 1939, approximately 1,000,000 telephones were in use, while 124,000 persons (the smallest number in 15 years) were waiting for the privilege to buy the use of a telephone number and to be permitted to have a telephone installed at an additional fee of several hundred *yen*. Telephone brokers bought up blocks of telephone numbers and resold them at prices usually ranging from 900 to 1,100 yen. The Government has supervised all trading since 1940, but the supply of instruments remains sadly inadequate, totaling approximately 1,100,000 at present. Six out of 7 telephones in use in 1937 were wall sets, the remainder, desk sets.

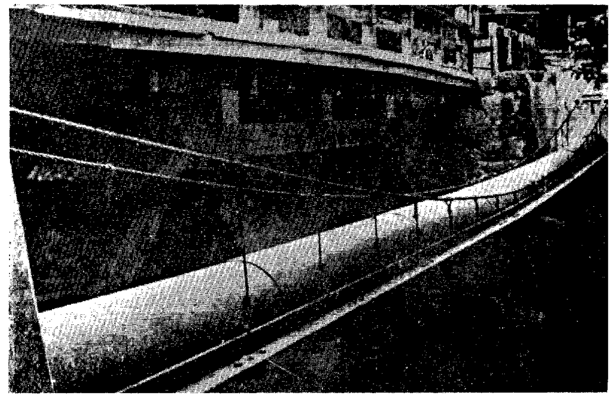

FIGURE VII - 54. *Suzuka-tōge (pass), Mie prefecture.*
Special bridge for cables paralleling Benten bridge.
34°53′N, 136°21′E.

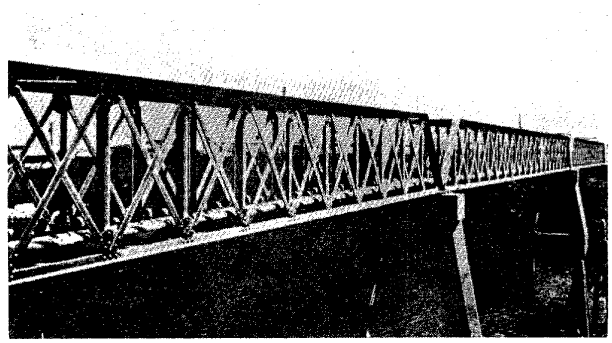

FIGURE VII - 55. *Ōsaka.*
Special bridge for cables, just outside Ōsaka.

FIGURE VII - 53. *Shizuoka prefecture.*
Armored cable crossing Tenryū-kawa on railroad bridge of the Tōkaidō line.

77. *Submarine Cables*

Japan has an extensive and well-planned network of submarine cables running between the various large and small islands and linking Japan with overseas countries (FIGURE VII - 57). While the network is well planned geographically, it suffers from poor maintenance. This lack is compensated for in part by alternative routes, but interruptions of service are nevertheless extremely high. The largest numbers of lines are found in the Inland Sea area and in Tsushima-kaikyō (strait) (FIGURE VII - 56). Other areas of concentration in Southwest Japan are near Kagoshima in southern Kyūshū and near Sasebo and Nagasaki in western Kyūshū. Most of the cables are for telegraph service only, but through telephone circuits are in operation between the leading cities of Japan and those of the adjacent mainland.

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A. Administration.

All submarine cables in Southwest Japan are under the direct control of the Transportation and Communications Ministry. Actual operations are nominally in the hands of the International Telecommunications Company, which is, however, entirely dependent on the Japanese government.

In the past, many of the international cables in the Far East were owned by the Great Northern Telegraph Company, a Danish firm. This firm's entire communications network in Japanese-controlled territory has been taken over by the Japanese Government. The degree of coercion which accompanied this transfer is not known, but the Japanese claim to have a contractural right to the properties formerly belonging to the Great Northern Telegraph Company. Rates for sending messages via Japanese-controlled cables have always been high. For this reason, it was customary in peacetime to send international press reports and commercial messages to Shanghai, whence they would be retransmitted to their final destination.

B. Maintenance.

Equipment and service on submarine cables appear to be adequate but frequent repairs are necessary because of poor maintenance. The most recent figures available (year ending 31 March 1938) report that interruptions caused by all types of mechanical faults totalled 124,772 hours, representing an increase of 62% over the preceding year.

Several telegraph cables and a large percentage of the telephone cables have been laid within the past 10 years. Many lines, however, are twenty or thirty years old, and the condition of the equipment varies widely on different lines. Three cable-laying ships are used for new construction and maintenance work; the most modern of these was put in service in 1938. In addition, it is possible that cable-laying and repair equipment formerly used by the Great Northern Telegraph Company in the Far East has been taken over by the Japanese.

C. Cable network.

The network is designed to give service to the islands to the north, to various points on the Asiatic mainland, and to Formosa and other islands to the south. In addition, there is a line to Guam, connecting with U. S. service to Hawaii and the North American mainland. Each of the most important overseas message centers—Fusan, Shang-hai, and Taihoku—is reached by several cables and by at least 2 different routes. If all cables should be out of service, messages could still be sent by radio to any of the points served by cable.

(1) *Kyūshū.*

Most of the cable messages to China, to the regions to the south, and to other continents are routed by way of the chief centers of cable communications on Kyūshū: Yobuko, Sasebo, Nagasaki, and Kagoshima (FIGURES VII - 56 and VII - 57).

Through wire routes between Shikoku and Kyūshū land at Saganoseki (33°13′25″N, 131°52′50″E), on the peninsula to the east of Ōita. At least one of these cables contains telephone wires. Several other cables leave from the northeast coast of Kyūshū, connecting with various points in Yumaguchi.

The narrow strait between Moji and Shimonoseki is crossed by several cables, including at least one for telephone service. Through circuits from Fukuoka to Ōsaka, Tōkyō, and other points use this route.

There is an important concentration of cable landings at Yobuko, the point on Kyūshū nearest to the Iki-shima (island). These lines, including at least 1 cable for telephone service, run to Fusan, Chosen, by way of Tsushima, most of them touching first at Iki-shima. Repeater stations on the telephone cable are located at Gonoura on Iki-shima and at Gōsaki on the northwest corner of Shimono-shima (South Tsushima).

Long-distance cables run from Sasebo to Dairen and to Tsingtao. Other lines near Sasebo connect many of the small islands in the Goto-rettō.

Most of the long overseas cables land at Nagasaki. Two run to Vladivostok, 1 to Dairen, 3 to Shang-hai, and 2 to Tansui, Formosa. One of the lines to Shang-hai handles telephone service.

The chief cable connection between Japan and the Ryūkyū-rettō lands at O-hama (31°11′00″N, 130°46′05″E) and continues by short submarine cable to Kagoshima. This route is also used as a link in the route for wire communication with Formosa.

(2) *Shikoku.*

Almost all the cable landings on Shikoku are for local communication, the majority of them connecting this island with southern Honshū. A notable exception is the through telephone circuit between Ōsaka and Shang-hai, which crosses the island (FIGURE VII - 57).

Few points on the northern coast of Shikoku are more than 5 miles from a cable landing. Through lines, including at least 1 telephone cable, land on the northeastern point, and leave the island via the narrow peninsula across from Ōita, on Kyūshū.

The Takanawa-hantō (peninsula), on the northwest coast of Shikoku, is connected by several cables with the Hiroshima-Kure region of Honshū.

No cables are known to land on the southern part of Shikoku.

(3) *Southwest Honshū.*

International cables run from the western tip of Honshū to Korea. A great many local cables run to Shikoku and to the small offlying islands (FIGURES VII - 56 and VII - 57).

One telegraph line runs from Chikumi (35°33′30″N, 133°08′30″E) to Genzan, Korea, by way of Utsuryo-To and Suigen Tan, Korea. From Chikume, other telegraph lines run to various points in the Oki-rettō, and a telephone line connects Oashiura (35°33′00″N, 133°02′50″E) with Nakano-shima in the Oki-rettō.

At least 6 cables connect Shimonoseki with Fusan, Korea. Of these, 5 telegraph lines leave from Yoshimi (34°03′30″N, 130°54′45″E), and a telephone line runs from Murotsu-shimo (34°08′02″N, 130°53′10″E).

Both telegraph and telephone messages travel by cable between Shimonoseki and Moji. In addition, there are several other lines between points on Honshū and points on northern Kyūshū.

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Many cables, perhaps 50 or 60, run to various small islands in the Inland Sea and to the island of Shikoku. Several of these are only 2 or 3 miles long, but the complete network provides numerous alternative routes for communication with the entire northern coast of Shikoku.

D. New construction.

Details concerning the extension of communications facilities have long been considered military secrets by the Japanese. In general, new construction appears to have been limited to alternative routes, where cable service already exists. An additional cable may have been laid to increase the number of telephone circuits crossing Korea Strait.

There are no indications that the Japanese have completed any long cable routes at any great distance from Japan proper.

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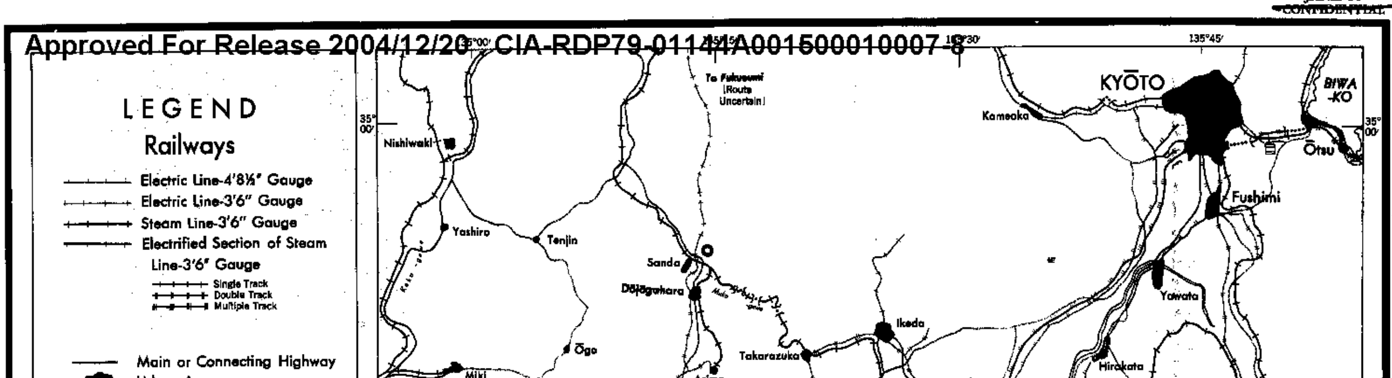

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FIGURE VII - 3. *Kyōtō-Ōsaka-Kōbe area.* Transportation.

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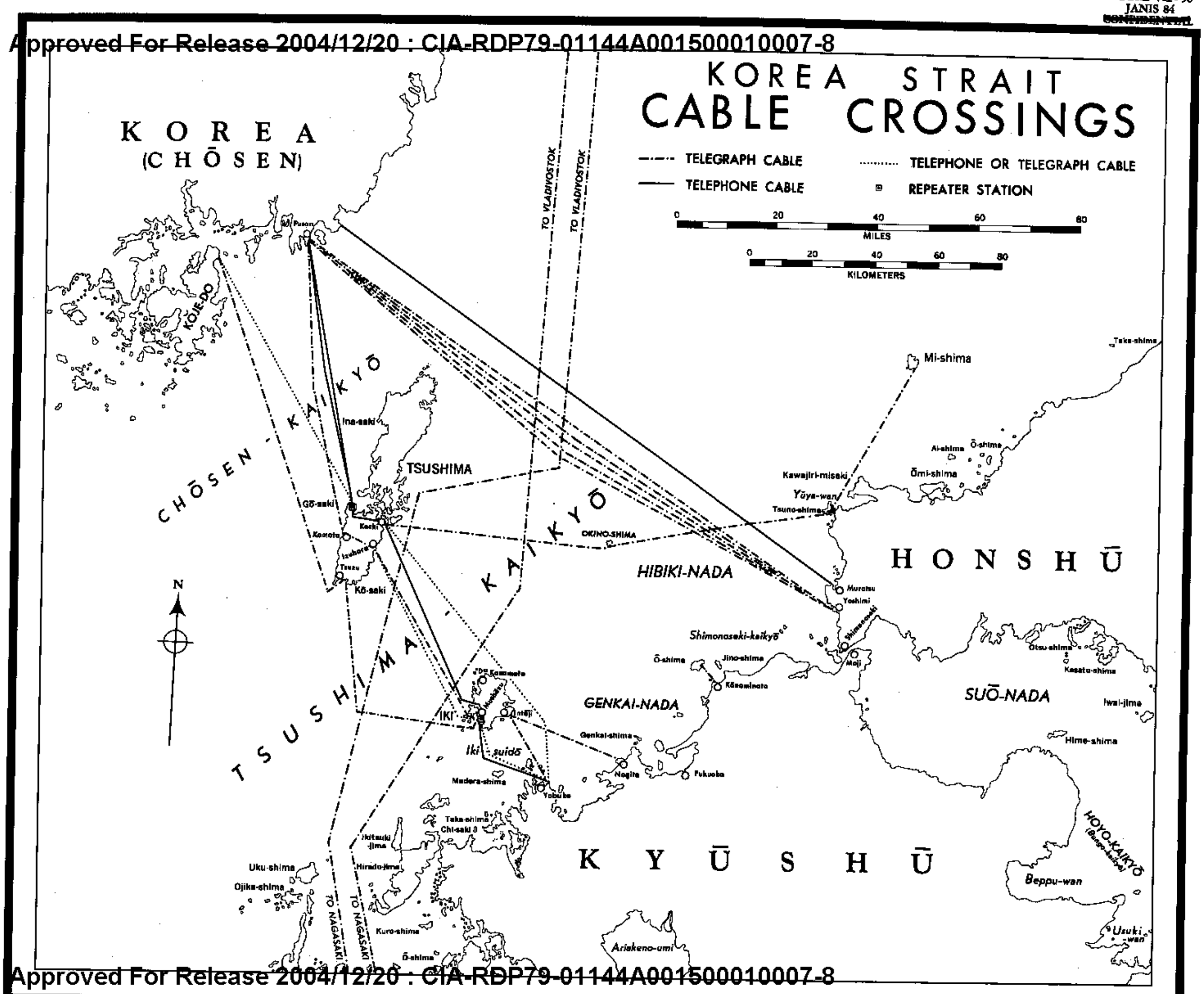

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FIGURE VII - 56. *Korea Strait.* Cable Crossings.

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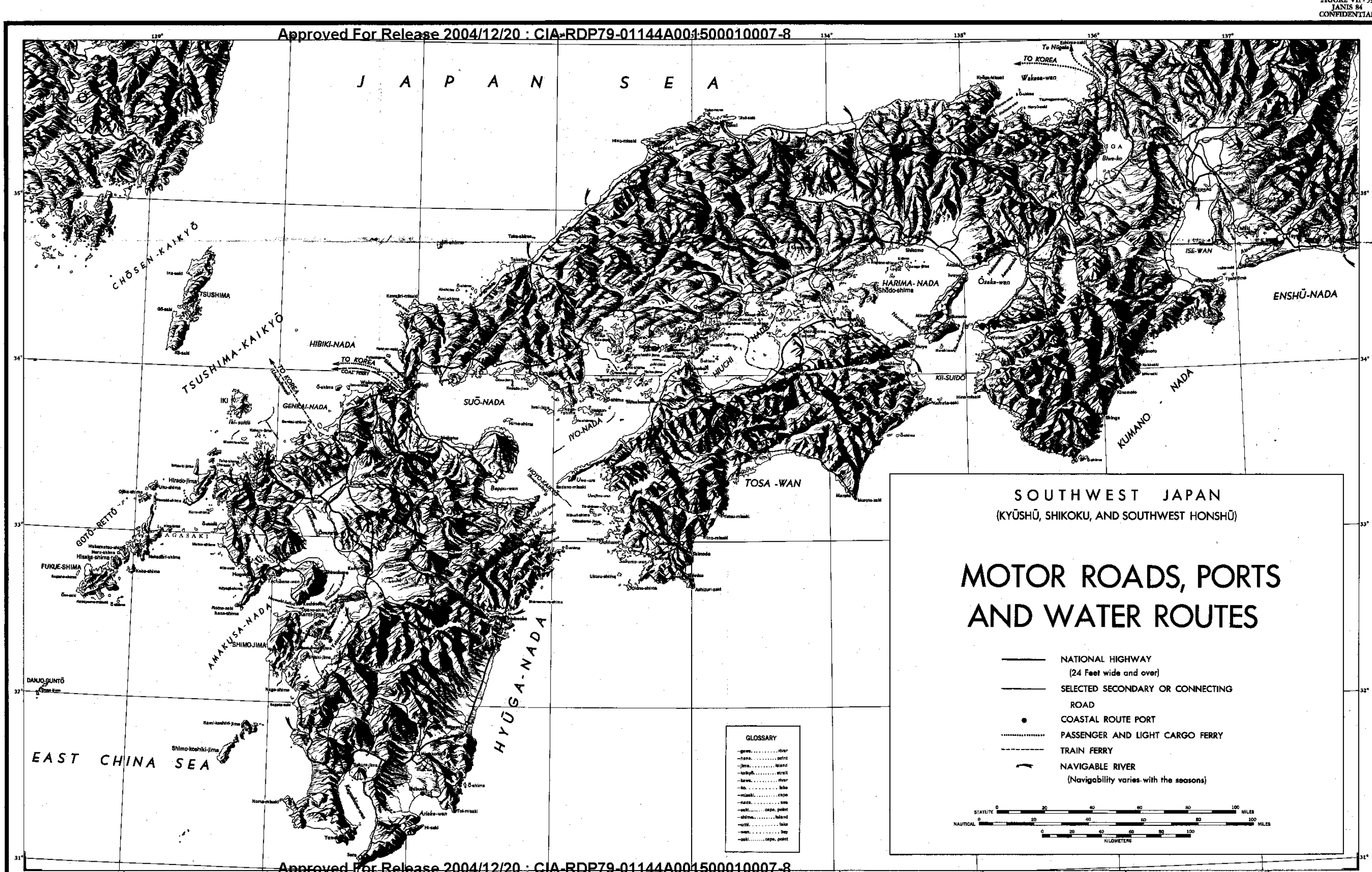

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FIGURE VII - 59. *Southwest Japan.*
Motor roads, ports, and water routes.

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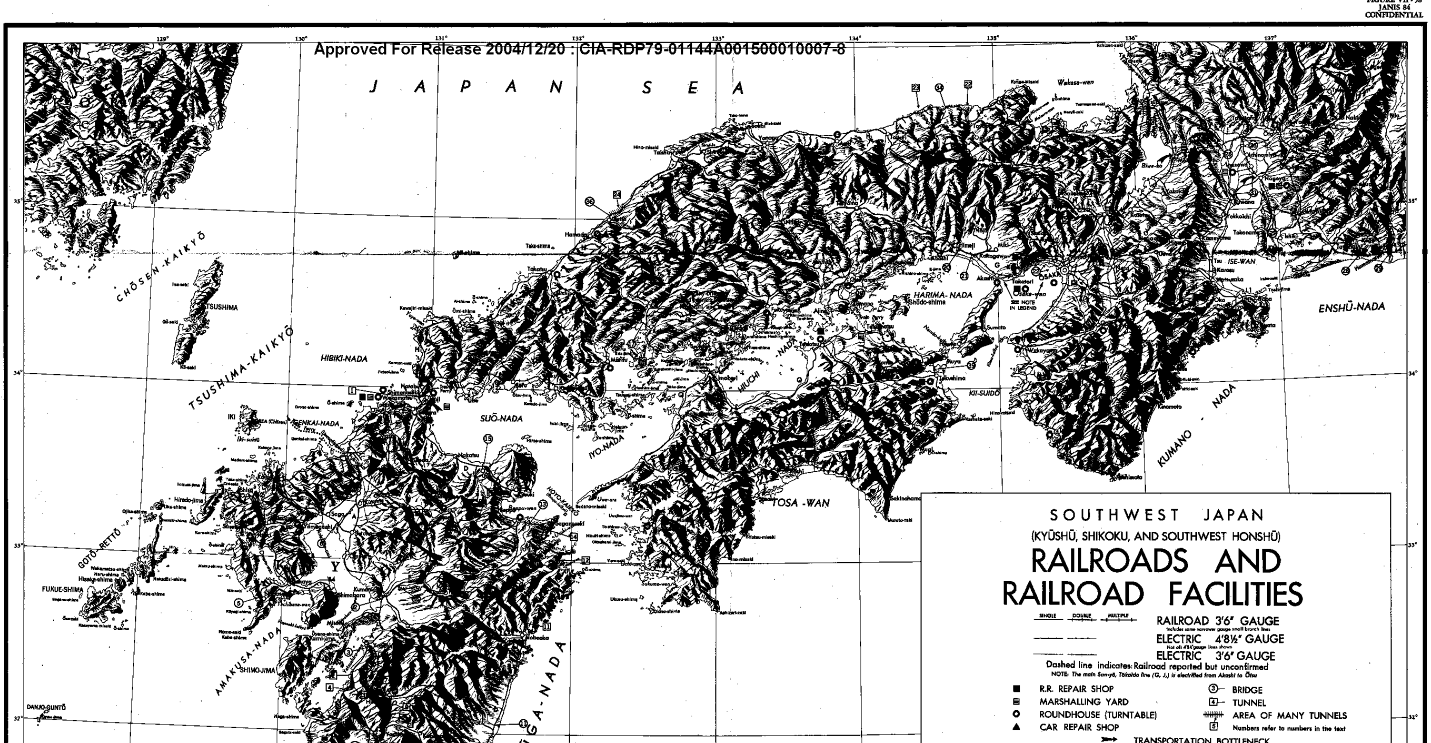

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FIGURE VII - 58. *Southwest Japan.*
Railroads and railroad facilities.

FIGURE VII - 57
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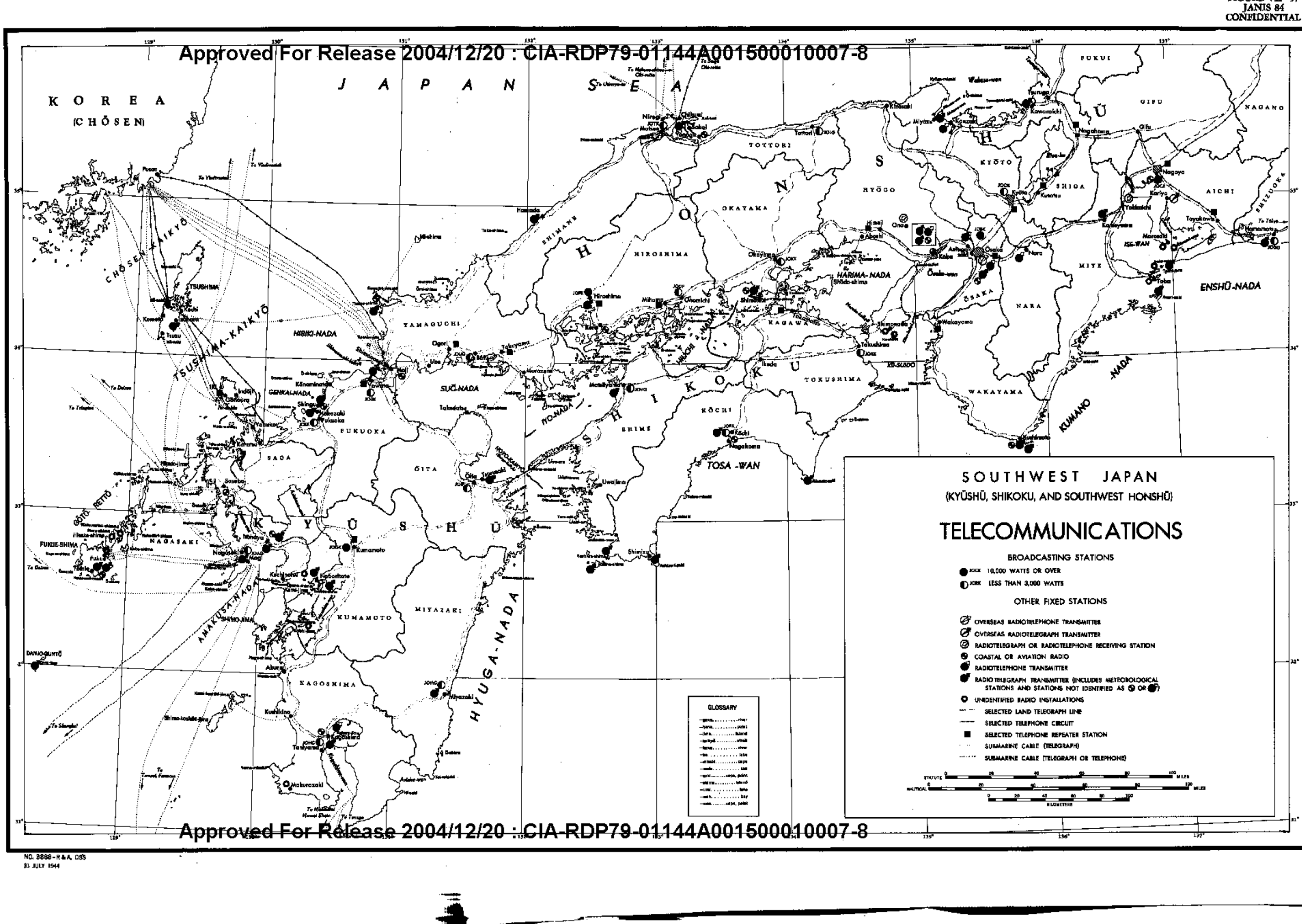

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